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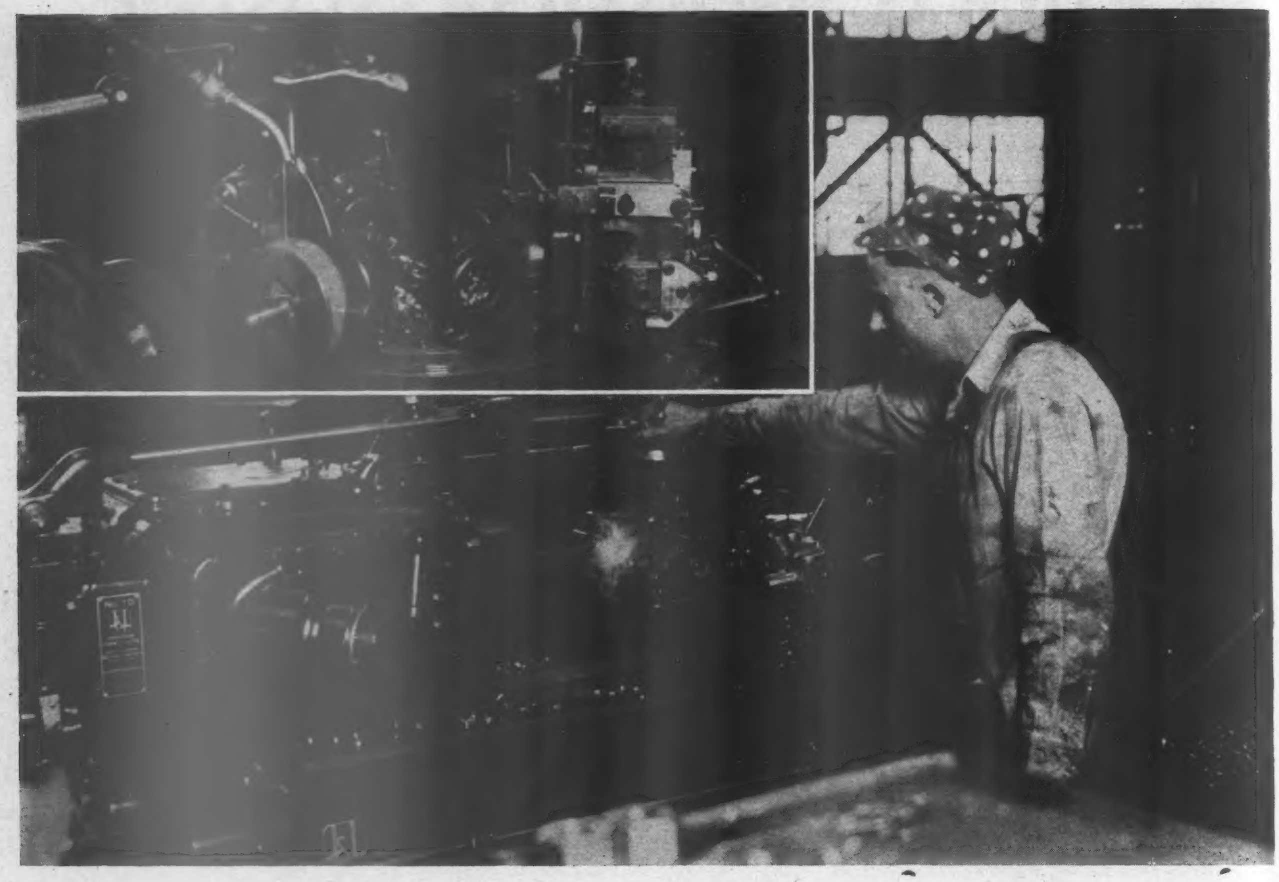

RAILWAY
MECHANICAL ENGINEER

Announcement of Prize Competition

THE railroads of the United States and Canada, the backbone of our transportation system and specially adapted to the rapid handling of mass transportation, are a most vital factor in the national defense program. Undoubtedly they will receive more consideration as to priorities as time goes on, but at the very best they will be greatly handicapped for the want of materials, adequate facilities and equipment, and a sufficient supply of skilled labor.

In this emergency mechanical department officers and supervisors must exercise their ingenuities and abilities to the limit, to secure maximum results with what they have to work with, whether men, materials, facilities or equipment.

Never was it more important to pool the best ideas and experiences in order to insure that the railroads and transportation do not form a bottleneck in national defense production.

The *Railway Mechanical Engineer* is desirous of doing its full part in the present emergency. To that end a prize of $200 is offered for the best article submitted on or before January 15, 1942, on ways and means of improving the mechanical department's operations or practices to increase production and secure a larger use from the equipment and facilities. The writer of the second best article will be awarded a prize of $100. The decision of the judges who will be asked to pass upon these articles will be final. All other articles which may be accepted and published will be paid for at space rates. Entries in the contest should be addressed to The Editor, *Railway Mechanical Engineer,* 30 Church Street, New York, N. Y.

There are many ways in which the mechanical department can do its part in securing the best possible results from available facilities and equipment. Merely as suggestions, typical of the wide variety of possibilities, one might consider the question of improved designs, or the conservation of materials, or the selection of materials. It is conceivable that marked improvements might be made by the better marshaling and use of manpower. Improvements can and are being made, in many instances, in the effort to speed up the repairing of cars and locomotives and of the maintenance and servicing of locomotives at engine terminals. Shop production is being slowed up for the need of more up-to-date tools and facilities and the lack of the best types of cutting tools. What can be done to increase production in spite of these limitations and handicaps? These are merely suggestions and the winning articles may cover other phases of mechanical department operations, not specifically mentioned.

The award will be made on the basis of the practicability of the suggestions and the magnitude of the results to be achieved, so far as it is possible to ascertain or estimate them.

The statement was made in connection with the recent mechanical conventions at Chicago, that the mechanical departments of the railroads were "on the spot". The statement was also made that up to this time they have been doing an unusually effective job in keeping the equipment in first-class condition and available for service. The indications are that the transportation facilities of this country must be prepared to bear still heavier burdens in the days to come. The mechanical department faces, therefore, a very great and grave challenge. We know that the officers, supervisors and men in that department will meet this challenge and we hope this endeavor of ours to pool constructive ideas and suggestions as to how to meet the emergency, will be helpful in this effort.

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Hawthorne Addresses Mech

V. R. Hawthorne
Executive Vice-Chairman, Mechanical Division, A. A. R.

THE four groups of mechanical-department supervisors which constitute the so-called Coordinated Mechanical Associations held simultaneous annual meetings at the Hotel Sherman, Chicago, on September 23 and 24. These associations are the Railway Fuel and Traveling Engineers' Association, the Car Department Officers' Association, the Master Boiler Makers' Association, and the Locomotive Maintenance Officers' Association. There was no exhibit this year by the Allied Railway Supply Association.

The meetings began with a joint opening session over which Frank P. Roesch, vice-president, Standard Stoker Company, and chairman of the Committee of the Coordinated Associations, presided. The meeting was opened with impressive ceremonies which included the raising of the flags of the United States, Canada, and Mexico, and the singing of the national anthems of all three countries by Mary Jane Nicholson, daughter of J. M. Nicholson, mechanical superintendent, A. T. & S. F.

Address of Chairman Roesch

Mr. Roesch, in a brief address, emphasized the importance of full co-operation between the various departments of the railroads under present conditions. He spoke, in part, as follows:

"The National Defense Program will impose a heavy burden on the railroads, affecting all roads large and small to some extent, but under the present setup of the Association of American Railways and the resultant coordination of effort, there can be no question about their ability to meet the present situation or any future emergency that may arise. There are no pessimistic railroad men; on the contrary railroading is something like football: the greater the interference the harder they buck the line. You are the fellows that will have to take the brunt of it.

"We hear on all sides cries of possible power shortage, car shortage, men shortage and material shortage. Those who write these articles—often inspired by advocates of other-than-rail transportation—either know little of the resourcefulness of railroad men, or are not concerned about facts, so long as their stories make good reading and are accepted as fact by an unthinking public who echo the cry, 'the railroads are breaking down; we must build more concrete highways, pipe lines, ship canals or what-have-you to meet the needs of national defense.' If they would look for facts they would find that the railroads have never failed to meet any emergency in the past, and through coordinated effort are now stronger than ever.

"Let us look at the problem from an unbiased standpoint, not as a local problem, but as a national one, and we will get a true picture as to the comparative value of rail and other means of transportation. In support of that statement, we quote from an editorial in the September 15 issue of the Chicago Daily News: 'The American industrial machine is still in the main an organism that draws its lifeblood through railroad arteries. To formulate any industrial policy without taking thorough counsel of railroad men is going out of one's way to invite trouble. The railroads have plenty of competent men at Washington to help the defense effort. Let us hope that hereafter they are asked what they can do before we have any more shortages, curtailments, panics and useless recriminations.'

"As but for one example to illustrate the point: Shipyards are located on both seaboards. Smelters and steel mills are located well toward the center of the continent. Conceive if you can the number of trucks that would be required to haul the prefabricated plates, beams, etc., to the points of assembly if they could be so hauled at all. Water transportation is out of the question, as speed is the watchword. If all can get this picture as it really is, they can readily see that rail transportation is the keystone of the arch and if that were to fail, the whole defense structure would collapse with it. If these truths are accepted, it should be clear to those who are in position to hinder or to help that, if half the consideration were given to railroads that is given to other means of transport, there could be no fear of any interruption of the defense program.

"You men are the selected leaders in your various departments. It is on you as contact officers with the rank and file that much of the burden will fall. It will be up to you to make two blades of grass grow where but one grew before. Your deliberations will result in promoting new methods of doing old jobs. Methods of conserving repair time in shops and terminals. Methods of obtaining more and better use from the material supplied, and through such methods increase the availability of power and equipment, and show the world that there is no such animal as a railroad man who is not equal to any occasion. If ever there was a time when railroad supervisory officers should get together and counsel with one another, that time is now."

Following his address Mr. Roesch introduced V. R.

Mechanical Associations

Four groups of mechanical department supervisors start successful two-day annual meetings with a joint session at which Frank Roesch presided

Hawthorne, executive vice-chairman, Mechanical Division, Association of American Railroads, who delivered the principal address of the joint session. At the close of Mr. Hawthorne's address the associations adjourned, each to reassemble in its own meeting room to take up its own program.

Mr. Hawthorne's Address

This meeting will, I am sure, be an inspiration and of great help to those who take part in the proceedings and discussions which have been so ably prepared. I wish to convey to you the greetings and best wishes of the officers and general committee of the Mechanical Division, Association of American Railroads.

As you are all aware, the American way of life has always been dominated by representative assemblies such as you have here. This goes all the way back to the town meetings of the early colonies in New England, through the period of the colonial assemblies and into modern times with the Congress of the United States and the multitude of societies, associations, etc., for the free discussion of all problems, political, economic, commercial, technical and practical.

Railway officers, some 75 to 80 years of age, when the interchange of freight between railroads first began, proceeded to organize themselves into groups and associations such as are meeting here this week. These associations provided a means whereby the officers of one railroad could meet the officers of other roads serving in a similar capacity and through reports and discussions exchange experiences and through the years improve the performance of all to the present state of efficiency. This progress has not stopped, but in a broad sense has passed from the elementary stage to the advanced stage where refinements and advanced technic are now the principal basis of discussion, report and endeavor.

In the early days of railroading in this country, railroad men with creative ability began to invent improvements in appliances and parts for locomotives and cars, which were patented. Companies were organized and plants developed for the manufacture of such appliances and parts, and there quickly developed an industrial group manufacturing parts and devices for sale to railroads. These manufacturers and builders of locomotives and cars in turn formed associations to consider and take action with respect to their common problems, particularly relating to the bringing of their products to the attention of the interested railroad officers.

Instructive Value of Exhibits

These groups of railway supply men have throughout the years arranged instructive and attractive exhibits of their products to coincide with meetings and conventions of railroad associations and have had no small part in the phenomenal development of our American railroad systems. Due to the stress of present conditions, no exhibit is being held with your meetings this year, but last year a splendid exhibit was held and was of great benefit to those in attendance. I hope that these instructive exhibits can be resumed after the present unsettled conditions have passed.

The science of railroading is always advancing. The application of scientific research to railroading has been an important factor in solving many problems. Among the large research projects of recent years may be mentioned the following: Air brake research program, extending from 1923 to 1933, resulting in the establishment of the present requirements for freight air brakes; air brake research progam of the last few years resulting in the establishment of the present brake equipment for high-speed passenger trains; axle research resulting in new designs of axle for passenger cars; truck research resulting in the development of a number of designs of trucks for high-speed freight service; research resulting in the development of improved materials for cars and locomotives such as: high-tensile steel plates, shapes, bars, etc., high-tensile steel castings, improved tires and wheels, improved forging materials, etc.; research in connection with roller bearing application to locomotives and passenger cars.

Much of this research has been a joint effort of the railroads and the manufacturers of materials which the railroads use. Very little of it has had any spectacular phases but has represented determined, conscientious and laborious effort on the part of both the manufacturers and the railroads.

A comprehensive series of road tests of locomotive counterbalance standards has just been started using instruments especially designed for this work. Laboratory tests will also be started in the near future to determine the causes for failures of main crank pins.

Continued Research Vital to Railway Progress

The continued research and study devoted to railroad problems and the application of new and improved methods, devices and materials as a result thereof has given to this continent the greatest system of rail transportation in the world. We have the most powerful and efficient locomotives. Our cars are of large capacity designed to fit the needs of our great industries, and, due to their rugged construction may be operated with but a small portion of their service life lost due to necessity of repairs. Our trains operate on fast schedules and carry more, so that their hourly output of transportation is double what it was 20 years ago. The fundamental wearing parts of cars have been so standardized that repairs may be made quickly from the material stock of any handling railroad regardless of the ownership of the car. Twenty years ago, freight car hot boxes on the road were approximately five times as frequent as they are now, per mile run, and engine failures were about seven times as frequent.

All of this past effort on the part of railroad men working largely through groups such as yours has brought about this record of accomplishment and has given us this great system of railroads which will play such an important part in the problems growing out of our present great national defense program. In other words, the railroads are doing their part in this emergency and have provided rail transportation adequate to meet present demands and will continue to do so.

The railroads however are still progressing. They will not stop progressing and call the job completed. The world in which we live is constantly changing and the railroads, in order to maintain their proper place in the nation's economic life, must not only keep pace with the needs of today, but must anticipate the needs of tomorrow and prepare to meet them.

Associations such as those meeting here at this time have had much to do with stimulating and directing thought to those problems that require intensive study. The information which you develop through your discussions and the recommendations which you transmit to the Association of American Railroads, I can assure you, will receive the most careful consideration. At this time any recommendation that leads to increased efficiency, improved equipment and maintenance or greater utilization of existing equipment should be thoroughly studied.

Car Officers Hold Succesful

Two-day session at Chicago is devoted exclusively to a consideration of current pressing car problems

E. S. Smith,
Vice-President

F. E. Cheshire,
Vice-President

A. J. Krueger,
President

G. R. Andersen,
Vice-President

F. L. Kartheiser,
Sec.-Treas.

...essful Annual Meeting

A TOTAL of 334 members of the Car Department Officers' Association registered at the annual meeting held at the Hotel Sherman, Chicago, September 23 and 24. After the joint opening session of the co-ordinated mechanical associations, which was addressed by V. R. Hawthorne, executive secretary, Association of American Railroads, Mechanical Division, as described elsewhere in this issue, members of the Car Department Officers' Association re-assembled for the consideration of problems pertaining exclusively to car equipment and its efficient design, maintenance and use on American railways. The general character of individual addresses and committee reports was well up to standard and again, as was the case at the last annual meeting, the work of the association was officially commended by representatives of the A. A. R., Mechanical Division, as well as by railway mechanical officers of high rank.

The meeting was presided over by President A. J. Krueger, superintendent car department, N. Y. C. & St. L. In his presidential address, Mr. Krueger stressed the need of conserving car equipment by every possible means, expediting the repair of all classes of freight cars when found defective, and increasing the co-operation between mechanical and transportation departments, with a view to affecting smoother and more efficient operation, especially in train yards in so far as it effects inspection, air brake tests, switching, etc.

Individual speakers at the two-day meeting included E. B. Hall, chief mechanical officer, C. & N. W.; W. D. Beck, district manager, Car Service Division, A. A. R., and D. S. Ellis, chief mechanical officer, C. & O. Other speakers not on the scheduled program, who addressed the association briefly included K. F. Nystrom, mechanical assistant to chief operating officer, C. M. St. P. & P.; R. V. Wright, editor, *Railway Mechanical Engineer*, and T. J. O'Donnell, retired chief interchange inspector, Buffalo, N. Y., who was formerly an important factor in the association when it devoted itself exclusively to a consideration of problems of car interchange. During the course of the meeting, the association accepted reluctantly the resignation of Vice-President E. S. Smith, master car builder, Florida East Coast, who resigned, owing to the press of other duties and was elected a life member of the association.

Standing committee reports were presented on the following subjects: High-Speed Passenger Brake Equipment, Chairman J. E. Keegan, chief car inspector, Pennsylvania, Chicago; Shop Operation, Facilities and Tools, Chairman R. K. Betts, foreman car repairs, Pennsylvania, E. St. Louis, Ill.; Maintenance of Streamline Equipment, C. P. Nelson, general foreman, C. & N. W., Chicago; Lubricants and Lubrication, Chairman J. R. Brooks, supervisor lubrication and supplies, C. & O. Richmond, Va.; Freight Car Inspection and Preparation for Commodity Loading, Chairman A. T. Wagner, general car foreman, M. P., Dupo, Ill.; Loading Rules, Chairman H. T. DeVore, chief interchange inspector, Youngstown Car Inspection Association, Youngstown, Ohio; Interchange and Billing for Car Repairs, Chairman E. G. Bishop, general foreman car department, I. C., E. St. Louis, Ill.; and Assistant Chairman D. E. Bell, A. A. R. instructor, C. N. R., Winnipeg, Man., Canada. Abstracts of these reports will appear in this and subsequent issues of *Railway Mechanical Engineer*.

Cooperation Between Railroads and Departments

By E. B. Hall

Chief Mechanical Officer, C. & N. W. and St. P. M. & O.

In choosing the rather far-reaching topic "Co-operation," I was much influenced by the marvelous example of this we are witnessing today, resulting great monetary savings and highly satisfied shippers. The railroad men in this territory now, more than ever before, fully realize the seriousness of delaying freight, and the strenuous and unselfish efforts all departments involved are making to prevent it, is a shining example to prove that despite the keen competition existing between railroads, they can and do co-operate with one another.

Fully realizing that the car department is one of the most important factors in the transportation game, I feel that it should be given the best possible support by executive officers and other departments. The car men can, by fully understanding their many and varied regulations, and by the use of good judgment, save enormous sums of money, and while they are doing very well, I know that they can do better.

Time, however, will not permit detailing my reasons for making this statement, except to say that, special effort should be made to obtain better service from freight cars, which no doubt will become more important than ever before in connection with the tremendous task before us. The mileage can and must be increased, and the shopping of loaded cars in transit can and must be reduced. To accomplish this will, I repeat, require the best kind of co-operation between railroads and departments of railroads, and it seems to me that you could do

Officers Elected for Next Year

***President:* F. E. Cheshire, assistant superintendent car department, Mo. Pac., St. Louis, Mo.; *first vice-president:* G. R. Anderson, district supervisor car maintenance, C. & N. W., Chicago; *second vice-president:* D. J. Sheehan, superintendent motive power, C. & E. I., Danville, Ill.; *third vice-president:* I. M. Peters, superintendent and secretary, Crystal Car Line, Chicago; *fourth vice-president:* P. J. Hogan, supervisor car inspection and maintenance, N. Y. N. H. & H., New Haven, Conn., *secretary-treasurer:* F. L. Kartheiser, chief clerk-mechanical, C. B. & Q., Chicago.**

nothing better than to effectively deal with all such matters.

I have heard it said that your association would be of little value to the railroads, but I have contended that if properly conducted it can be very helpful, even though its activity is confined to bringing about better co-operative relationship, and a better understanding of how best to perform the duties assigned to you. Some may gain the impression that discussing your various classes of work repeatedly does not make for progress, but I deem that far more productive than to strive too much for new development, particularly so, when it becomes a matter of duplicating the work handled by the A. A. R.

In this connection may I say that the personnel of your various committees is tremendously important. The success and accomplishments of your association depends to a great extent on the earnest study and activity that these men so unselfishly devote to their particular assignment. . . . We often find men of high ability reluctant to act as chairmen of committees, largely for the reason that committee members cannot find time to attend meetings or assist by correspondence in the work of their committee, thereby placing a greater share of the work on the chairman. This situation, if continued, can only lead to a general breakdown of association activity, which in an association of this character and purpose would be exceedingly unfortunate.

I have arrived at the conclusion, which to some extent may be an admission on my part, that the remedy to this lies largely in the hands of chief mechanical officers. More car and locomotive department officers must be given permission to attend conventions of this character. Men selected for committee work must be given to understand that their supervisors encourage and support activity of this nature. That they be given full release from their railroad assignment to attend committee meetings, when called, is evidently very necessary. In other words, a more tolerant and co-operative spirit toward association work on the part of mechanical department heads is necessary. You may rest assured that I will do everything within my power to accomplish that result.

Present Car Conditions Requiring Attention

May I call to your attention a few matters which under present conditions appear to me to be of vast importance in the satisfactory movement of freight. In the prompt and proper classifying of freight equipment to secure full utilization of cars, the closest kind of co-operation with the Car Service Division is highly essential. Many miles of empty car haul can be avoided by intelligent inspection and commodity carding of cars at terminal points.

Avoiding the loading of bad order cars, particularly with defects of a nature that may result in transfer of lading at the first interchange point. There is still considerable to be accomplished in greater promptness in repairing loaded cars. Practically every commodity moving today calls for quick delivery to destination but regardless there are countless instances where cars marked out in terminals and particularly from noon on are held over some times as long as 24 hours, whereas with proper facilities and full co-operation from your operating departments, the cars in most cases could have departed on schedule.

Perhaps never in the history of the railroads were there as many loads of different character and size moving on open-top cars as there are at present and, therefore, it is exceedingly important that extreme care be exercised in seeing to it, first, that these loads are loaded strictly in accordance with A. A. R. loading rules, and second, that they be carefully inspected at all terminals enroute to determine that they have not been disarranged. Naturally it is likewise important that the equipment furnished for such loading is not defective, in order that the lading be properly secured.

I have been much impressed with your temperate method of functioning since you re-organized under the jurisdiction of the Association of American Railroads, and I feel confident that your future efforts will create improved team work and prove highly beneficial to your employers.

Conserving Railway Equipment

By W. D. Beck

District Manager, Car Service Division, A. A. R.

War and war prospects are uppermost in the minds of every one and taxes are probably next. I am making a guess that the third apprehension is the question of prompt and safe transportation of materials whether these be for National Defense or for consumption at the breakfast table.

United States railways have been "on the spot" for a good many years; they were lambasted hither and yon for car shortages up until about 1922, but since that time there have been no shortages of equipment, nor of transportation requirements. As a matter of fact, they are moving the present business with a smoothness and regularity never before equalled.

Two reasons account for this: (1) The rehabilitation of the properties at an expense of some eight or ten billions of dollars following the return from government control, and (2) the organization of Shippers Advisory Boards, of which more anon.

In naming these two reasons, I am not unmindful of the very great part that your organization occupies in the field of transportation. To you is given the responsibility of designing the equipment which must be acquired. To you comes the additional responsibility of seeing that, once obtained, it must be kept in perfect repair and this matter of perfect repair these days means much more than just having a box on wheels as was once the case.

Today shippers and receivers of freight require a car which will carry the most fragile and the most elusive of materials from one end of this country to the other without damage. You know this and you know too that the average person would be amazed if he were told what we had to do to and for a car, flat, box, or otherwise, before it could be accepted to carry most any kind of a shipment.

But enough of that because it is your job and mine, and of course we conform. Let us not forget, however, that the present increased loading and consequent plus in our revenues, is not going to cure the steam railroad financial situation because of the many inroads thereupon, with more to come.

The railroads today own about 1,660,000 cars. They have put into service since January 1, 1941, 49,000 cars. They have on order 92,000 cars and others will be purchased early for 1942 and 1943, the number of which, of course, will depend upon the priority orders for the necessary materials. The average carrying capacity of all these cars is better than 50 tons each.

The bad order situation, 4.8 per cent, not only for light but for heavy repairs is the best in the history of man and reflects the ability of your organization (plus, we ought to say, a little more easily-opened pocket book). Thus, we are geared up to loading 900,000 cars and better, per week and it is not requiring any great effort to maintain that altitude day after day. I am satisfied we can go to 980,000, or may be a million by continuing a constant alertness.

Strangely enough, our net ton miles are almost even with what they were in our bounteous years of 1926 to 1930. A surprising thing, due of course, to two things; (1) the increased speed of freight trains, and (2) the larger carrying capacity of our freight cars. As to these two items, the car and locomotive departments deserve much credit.

Incidentally, every freight car owned by United States Railroads in 1941 performed three-fifths more transportation service than in 1918.

The Function of the Car Service Division

May I put in just a word or two about the Car Service division and their especial responsibility in seeing that car service rules are observed. This is not an idle gesture, but is intended to bring about a condition which you as maintenance men fully

appreciate, you want your own cars home so that they may be in proper repair.

We try to bring that about, (1) because the owners are entitled to the use of their cars, and (2) because we know that expert maintenance of equipment will result, and (3), because long experience has taught us that car service rules observance brings about an adequate car supply.

I said we would consider the Shipper's Advisory Boards later. These are great organizations, there being 13 of them in the United States, their respective areas conforming to the Car Service division districts. They were formed, as you know, to co-operate with the railroads in matters having to do with transportation. Not since their formation have we had a car shortage. We do not expect one and will not have one so long as these shippers do what they are doing for us today, i. e., releasing cars within free time, loading cars to capacity, ordering cars only as needed, loading cars without delay and loading them in accordance with car service rules wherever it is practical.

This is not just idle talk—these men are doing exactly what I've said and are crying for more opportunities to help. They have, indeed, organized Vigilance committees all over the United States to see that every shipper does his part in the prompt release of loaded cars in the complete unloading of cars so that with dunnage, bracing and other paraphernalia removed, it is ready for the next shipper without going to the cleaning track.

These committees will watch every phase of the freight car game. There have been 70 or 80 set up in this Mid-West Shippers Board area of Illinois, Iowa, Wisconsin, Upper Michigan and Western Indiana. They know, you know and I know that with so many misguided people seemingly hungering for government control of the railroads we just cannot slip once. We all know that with shippers, receivers and railroad organizations, such as yours, working and pulling together, as to any transportation burden placed on the railroads, whether it be a million, or a million and a half cars a week, we will get away with it.

I would be amiss in failing to mention the very considerable loading not only now extant at ordnance plants and other government institutions, but that which is in prospect. Such places as Savanna, Elwood, Kingsbury in Illinois, and many such places elsewhere, will soon be in full production, and all will require the highest grade of car. We shall have our work cut out for us there and then.

Let me say this for the real government agencies. In this great defense program which they are engineering, the railroads are receiving their most skillful help in the matter of heavier loading, in the non-delay to empty cars awaiting loading and (more than anything else) in the prompt release of equipment.

Many of us remember what happened during the last war when 200,000 cars loaded with government freight were delayed (some of them for months) awaiting release from load.

Absolutely nothing of this sort is occurring today; in other words, government authorities are co-operating a thousand per cent.

Better Maintenance of Freight Cars

By D. S. Ellis

Chief Mechanical Officer, Chesapeake & Ohio, Cleveland, Ohio

The ultimate goal in the maintenance of freight car equipment should, as with locomotives, be sought on the basis of maximum economy to the railroad consistent with demand and expeditious movement of commodity to destination, which means a minimum of interruptions in the continuity of such service. To realize this attainment to the extent possible, of course, involves many contributing factors which must be co-ordinated by the supervision in all departments in order to produce the desired results.

It is necessary that all employees know what is required of them, and this leads to the advisability or necessity of preparing and issuing complete standard instructions to all concerned, including shop supervision, and that all be required to understand such instructions and perform their work in accordance therewith. Properly prepared instructions should be a valuable guide to the workmen and especially effective in promoting standardization in repairs to equipment. I cannot lay too much stress at this time on the necessity of carefully policing and following up to see that these instructions, when issued, are properly adhered to and followed, for the success or failure of improved maintenance depends on how carefully the job is policed.

Train yard repairs, such as putting in journal bearings, brake hangers, and pins, tightening loose running boards, box bolts, safety appliances, etc., if handled satisfactorily, become an appreciable item of economy in addition to preventing delays in car movement. It is of great importance that all materials and tools be properly distributed in repair yards, readily accessible to the repair men, in the interest of conserving the time of said repair men. Consideration should also be given to the proper location of clothes lockers, drinking water, and the many other numerous items and facilities required, in order that they be located to the best and most economical advantage possible.

Empty foreign cars known to be enroute home, if in safe condition to move to home line, and barring safety defects, should not be shopped. Such practice if adopted by all lines, would eventually lead to each road repairing its own cars, and such practice is also in accordance with Rule 1 of the Code of Rules for the Interchange of Cars.

Records prove that the average car is on the light repair track several times a year. The ideal situation would obtain if cars could be given necessary repairs at the time they are shopped for repacking journal boxes to keep them running until the next repacking—a period of approximately 14 months. This may seem too long but it is not impossible of attainment except insofar as failures occur which are completely beyond our control, such as defective wheels, damaged safety appliances, worn out brake heads, etc., but with improved maintenance even such failures should decrease in frequency.

The possibilities for increasing the time between shopping of cars is at once obvious to all of you car department men when it is realized that each of you can, no doubt, recall many instances of seeing cars on the repair tracks within a week or two of the time they were previously on repair tracks shopped for repairs that you know should have been made at the first shopping. Examples may be cited, such as decayed running boards, defective wheels (for one purpose or another), worn-out brake heads, low couplers, etc. These examples, to my mind, are the result of carelessness on the part of repair track supervisors. We have known instances on our lines, of cars being on various repair tracks three and four times in as many days and for repairs that should have been made at the original shopping.

It is very significant to consider what may be accomplished by interested co-operation and co-ordination on the part of the operating department. We have dwelt on some of the essential items on repairs to equipment. To prevent damage to equipment through rough handling and thereby effect much economy is well within the scope of possibilities. It is a familiar sight to see cars kicked in switching, with such speeds as are certain to result in damage to equipment and lading. Damage due to such impacts are very costly to repair since the car structure is frequently damaged, center sills broken, ends bulged out, draft gear stops broken, etc., all of which involve labor and material for repairs, and a break in the continuity of service. Renewal of broken couplers and draft gears on such damaged cars is frequently required, and car parts too numerous to mention fail under certain conditions of high speed car impact.

Much has been said of damaged car equipment due to the carelessness on the part of train crews, but relatively little accomplished. Co-operation, therefore, between the operating and mechanical departments to improve this situation is not only timely, but necessary. May I suggest here that your organization make this a subject for consideration jointly with

the Operating department. Improvements will depend upon the interest created. The Operating department can help by keeping cars fit by proper handling.

Co-operation between repair track, shops and designers of equipment, and our engineers, should be encouraged since suggestions from the men themselves who make the repairs to equipment often result in designs which are more easily repaired, lower in initial cost, and most economically maintained. In writing specifications for new equipment little or no thought may be given to the practicability of removing or replacing a part unless contact is had with the men doing such work in the field who are in a position to know where difficulty is experienced. In fact, it is being more and more appreciated today that the need exists for suggestions from men in the field, and many suggestions for improvements have accordingly been included in new designs. This feature in design should be uppermost in mind with the thought, of course, that strength must always be safeguarded, and ease of removal and replacement must be accomplished but not at the cost of weakening the freight-car structure.

Lubricants and Lubrication

Careful and extensive checks have been made of journal box packing as found in journal boxes of many cars from various ownerships, and the following are some of the conditions found:

A. A. R. Rule 66 is not being complied with in the packing of boxes, in that many boxes have been found to be not only overpacked but improperly set up. It is again emphasized that this matter should be called to the attention of the officers not only of the railroads, but also the private car companies who are responsible for this practice.

Many cars have been checked and the condition of the packing noted, and from this observation there is only one conclusion possible, which is, many companies are doing a very poor job of reclamation as packing in boxes of some cars with new packing dates has been found to be dirty, gritty and a large per cent of packing with short ends, etc., in fact on some cars with new packing dates the condition of the packing indicate the only thing new about the job was the markings showing repack point and date, and in order to correct this condition, it is recommended that consideration be given to suggesting to the A. A. R. that the A. A. R. inspectors in Division V, Mechanical be required to obtain a sample of reclaimed, saturated packing from each point inspected and such samples be sent to a designated laboratory for analysis, and when samples are found that do not comply with the A. A. R. requirements the A. A. R. so advise all member lines and the offending company be prohibited from billing for packing of journal boxes as set up in A. A. R. Rule 66. This step we believe is necessary and will go a long way towards correcting inferior methods of reclaiming journal box packing.

Hollow Back and Corrugated Back Journal Wedges

In the examination of many hot journals this type wedge is being found, some in very bad wornout condition. It is very evident that these wedges are not being closely inspected at the time of periodical repacking.

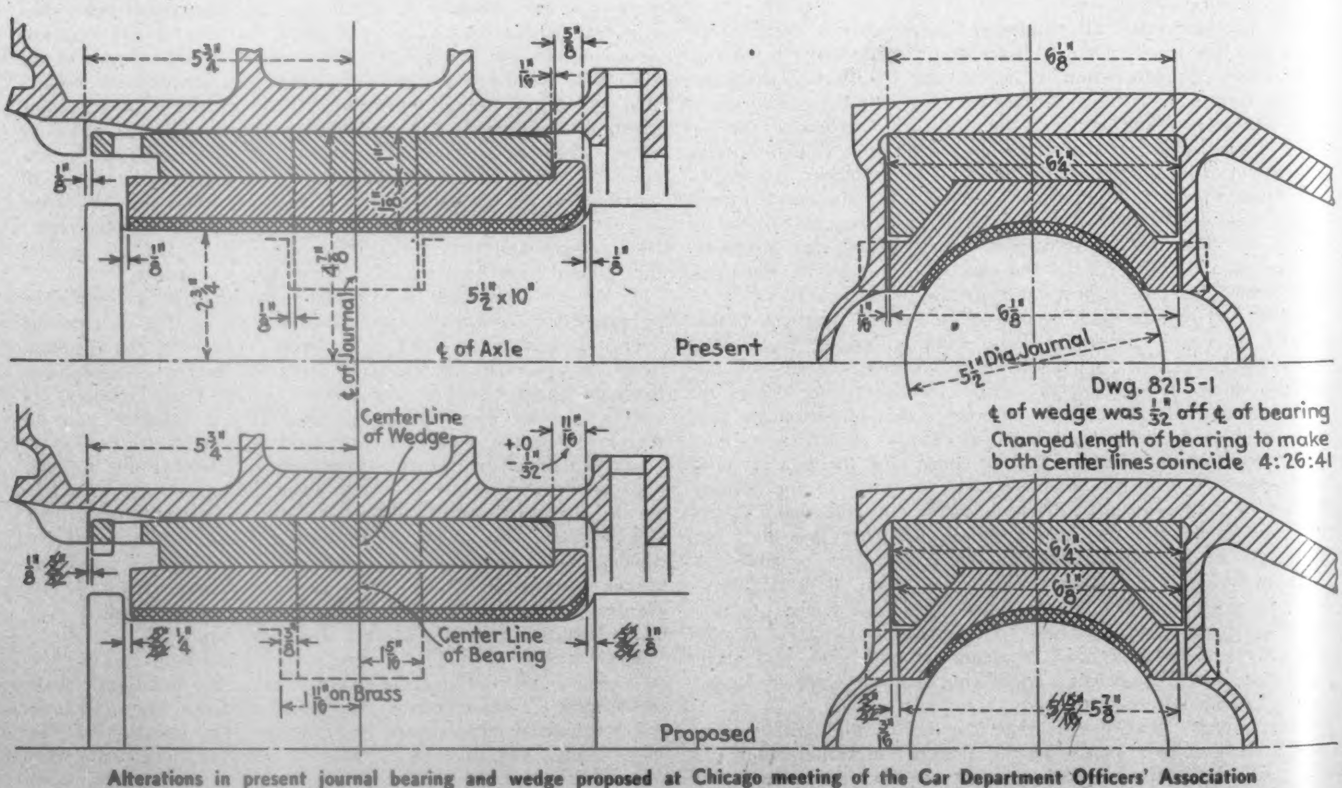
Your committee is of the opinion that these wedges should be closely inspected and removed from service as soon as possible and replaced with the journal bearing wedge conforming to the A. A. R. specifications.

Refrigerator-Car Drains and Drip Pans

Considerable trouble has been experienced with hot journals due to the improper maintenance and design of drain and drip pans on such cars. The drain and drip pans either rust out or get out of place, allowing the water to drain directly on top of the journal box, and in many cases directly into the journal box, particularly when box lids are not properly maintained or missing. This water in sufficient quantity will wash out the oil, which will effect the proper lubrication of the journal and cause trouble. It is our recommendation that this matter be called to the attention of the refrigerator car owners for correction.

Proposed Changes in Present Standard Bearings

Following up last year's recommendation regarding the necessity of changes in the dimensions of the present standard bearings. The question of the complete box assembly has been given



Alterations in present journal bearing and wedge proposed at Chicago meeting of the Car Department Officers' Association

considerable thought and this feature was considered by your committee with the following conclusions:

(a) That regardless of dimensions present or proposed all such dimensions and tolerances as set up by the A. A. R. be held to by all manufacturers, and when wedges, side frames (boxes) or bearings are being offered by any manufacturer that do not come within the prescribed tolerances, such units be rejected.

(b) That all such units be used in equipment which will be offered for interchange must be inspected, and the use of such units not coming within the prescribed tolerances be prohibited in equipment which will be offered for interchange.

(c) All wedges must be finished square on ends and sides so that square contact will be made.

(d) The attached drawing No. 8215* shows the action of the present standard bearing and wedge.

(e) Drawing 8215-A* shows the changes for the brass and wedge as recommended by your Committee.

(f) Drawing No. 8215-1 shows the present and proposed wedge, brass and box, and it will be noted that the brass is tapered on the end in order to allow free movement of the wedge on the brass at the collar end of journal.

You will note we have used the 5½-in. by 10-in. assembly on Drawing 8215-1. Changes in all other size bearings, wedges and boxes should be in similar proportions.

* Not included in the present abstract of the committee's report.

Your committee feels that with the proposed changes; i.e., closer inspection of all materials to assure compliance with limitations as set up, properly prepared packing—new or reclaimed, good workmanship in packing and setting up boxes—a much better hot box performance will be made by all concerned.

The report was presented by Chairman J. R. Brooks, supervisor of lubrication and supplies, C. & O., Richmond, Va.

Discussion

The discussion of this report brought out that the general purpose, in recommending changes in overall dimensions of the journal brass and wedge assembly and the application of a taper to the outer end of the brass, is to assure a design which will put all of the lateral thrust on the wedge and thus prevent undue wear, slipping or spreading of the brass lining with attendant hot boxes and train delays.

F. E. Cheshire, assistant superintendent car department, M. P., said that the tolerances now permitted render the wedge ineffective in resisting forces at right angle to the axis of the journal, and that the recommendations in this report constitute one of the most constructive things this association has ever done.

(The report was accepted and recommendations ordered referred to the A. A. R., Mechanical Division.)

Freight Car Inspection for Commodity Loading

The committee, realizing that our time is limited this year, has endeavored to sum up their discussion of and reaction to the assigned subjects as briefly as possible without omitting reference to some of the more important subject matter. After analysis of reports previously submitted, and the discussion pertinent thereto, we felt that a majority of the members of this association favored the adoption of a uniform commodity card, to be used in connection with a uniform set of general instructions to cover the selection and inspection of cars for loading various commodities. We believe that the adoption of a uniform card will be of advantage to all railroads, but appreciate that inauguration of its use will not immediately correct all of the errors in judgment in classification of equipment by inspectors and others. This feature must be policed locally and if properly done then we feel that eventually the use of the uniform card will eliminate duplicate inspection and reclassification. Only by such policing by local car department supervisors and strict adherence to the uniform instructions, can this be accomplished. The card itself cannot do it.

In an effort to emphasize to those here today, the large number, various sizes and kinds of commodity cards now in use, we have prepared and set up before you, an exhibit showing samples of cards submitted from many roads. It should be obvious from this that a uniform card is needed, also that the card shown in Circular T-25, issued under date of December 17, 1937, met with some favor, as you will notice several of the roads have patterned their cards after it. This card has been referred to many times before in reports and discussions; it is uniform card that was recommended by the A. A. R.

Several samples of proposed cards were received by the committee, who, after careful consideration, selected the one, illustrated, to be submitted for your approval. Its merits will undoubtedly be threshed out here, following presentation of this report. Also to facilitate handling to a conclusion here, we have had some samples printed for distribution among you. We shall not attempt to cover all of the details in this report, believing that these can be brought out better by discussion. However, a list of the commodities coming under the letter symbols, as drawn up by the committee, is included in that portion of the report covering uniform commodity requirements.

Class A Car

For high-class freight, such as cereals, coffee (non-roasted), copra, doors (glazed), flour—flax, grain products in paper carton and sacked, meal, paper (news print, etc.), paper cartons, phosphate, sacked food products, salt, sugar, sulphate, starch, soda ash, tin cans, tin plates.

1.—After classifying, this car will be loaded and forwarded to a destination probably hundreds of miles from your point. Before applying commodity cards, examine the trucks, wheels, running gear and car body with a view of bad ordering any car which has defects that might cause it to become bad order enroute, in preference to using it for loading.

2.—Car must be clean and free from contamination such as odors, oil, grease, dust, poisons and other residue from previous loads on interior of car and must not have:

(a) Protruding nails, screws, bolts, or loose, rough or broken lining, floor, etc., slivers, patches, or any sharp or rough edges or projections such as may penetrate or tear the sacks by contact.

If interior shows water stains (indicating leakage), examination shall be made to determine the defect has been corrected.

(b) Leaky roof, or roof sheets loose or shifted.

(c) Sheathing loose, leaky or with crevices, holes or any other defects that may let rain or snow into the car.

(d) Leaky doors, or otherwise defective, not fitting closely at top, bottom or sides of the opening, such as may permit leakage of rain or snow into the car, door fixtures (including locks, hasps, etc.), defective or missing, door stops (front), bent or broken, if preventing proper closing and locking of door.

(e) Broken or loose door posts, or side or end posts broken or out of place.

Car must be weather-proof at sides, ends, roof, and doorways, (this to be determined by getting inside the car, closing doors and observing whether daylight penetrates at any point).

Class B Car

For freight such as: Beans (bulk), black sheet, cement, carbide, explosives, excelsior, fertilizer in bags, etc., tobacco, grain and feed (bulk), glass bond, matches, malt products in paper cartons, ore, plaster, steel—finished plate, stucco.

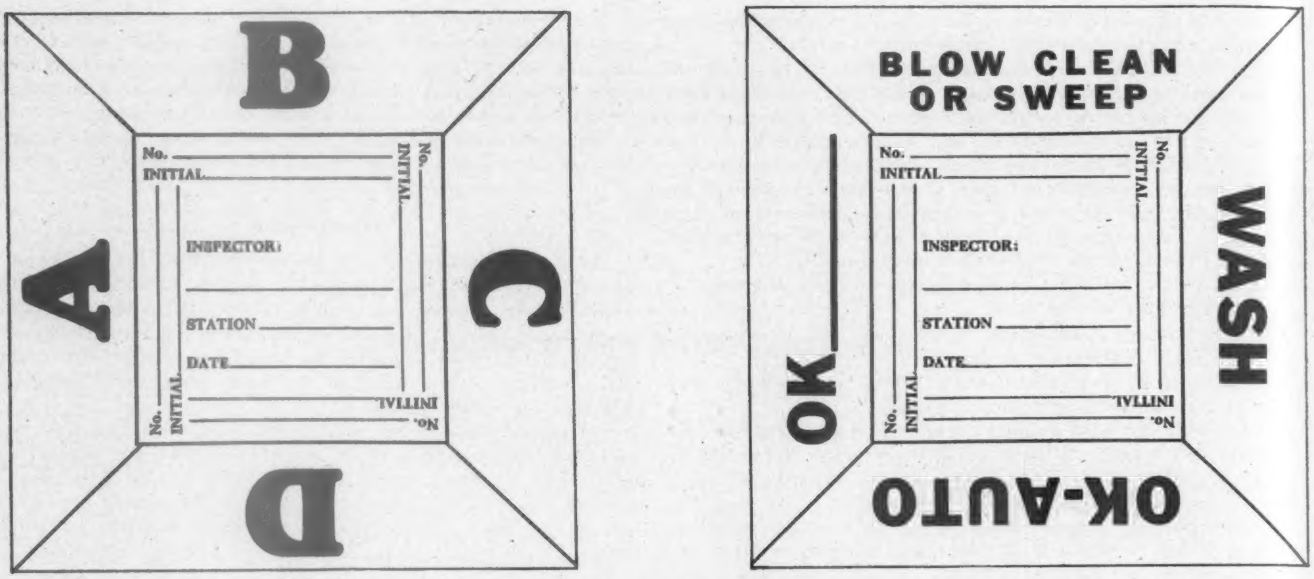
1.—Same as for Class A car.

2.—Car must be clean and free from contamination such as odors, oil, grease, dust, poisons and other residue from previous loads on interior of car and must not have:

(a) Floor broken or with holes or crevices, or loose fitting, as may permit leakage of grain, ore, etc. Protruding bolts, blocking or floor patches, etc., that may interfere with the use of unloading scoop.

(b) Lining, missing or broken. Where beveled grain strips are standard to car they must be intact and properly fitted to prevent leakage.

(c) Posts, braces or other parts of superstructure broken, decayed or loose fitting.



Front and back of commodity card which the C.D.O.A. recommends for adoption as standard by the A.A.R., Mechanical Division

(d) Roof leaky, or roof sheets loose or shifted.

(e) Sheathing—open, decayed, holes in same, loose, broken or any other defects that will permit leakage.

(f) Doors broken or defective to the extent rain or snow can enter car. Door fixtures (including locks, hasps, etc.), defective or missing. Door stops (front) bent or broken, if preventing proper closing and locking of doors.

Car must be weather-proof at sides, ends, roof and doorways. This to be determined by getting inside of car, closing doors and observing whether daylight penetrates at any point.

Class C Car

For freight generally recognized as merchandise, such as agricultural implements, auto parts, cotton, charcoal, candy, canned goods, dry goods, furniture, graphite, hardware materials, roofing, radiators, refrigerators, sulphur, tanks, tubs, wire (woven), etc.

1.—Same as for Class A car.

2.—Car must be clean and free from contamination such as odors, fresh oil and grease spots (dry spots without odor will not warrant rejection), coal and cement dust or other residue from previous loads on interior of car and must not have:

(a) Protruding nails, blocking, etc., that may cause damage to lading.

(b) Leaky roof, sides or ends that will permit damage to lading.

(c) Missing or defective doors and door fixtures that will prevent proper protection to lading and closing of doors.

Class D Car

For freight generally recognized as Rough Freight, such as acids, bolts, car wheels (loose), castings, drums, hides, lumber (rough), pig iron, pulp, rough mill freight, spikes, slag, tar, ties, wire, etc.

1.—Same as for Class A car.

2.—Car should be reasonably clean but does not need to meet the requirements of a Class A, B or C car, and must not have:

(a) Protruding nails, blocking, etc., which may cause damage to the lading.

(b) Floors that are not in serviceable condition.

(c) Doors and door fixtures, that are defective or missing, or doors that cannot be properly closed and locked.

Automobile Car

Equipment furnished for loading of automobiles must have good tight sheathing and roofs to prevent leakage of rain or snow into the car.

Car must be clean and free from contamination such as odors, dust, poisons and other residue from previous loads; also protruding nails, bolts and old blocking.

Flooring must be in good condition in order to properly secure automobile.

Cars equipped with auto racks, "auto loaders," must have such equipment properly maintained and same should be carefully inspected and tested before cars are applied on order. These racks should be raised into position next to roof of car and properly secured when cars are empty.

Your committee realizes that all commodities are not listed in the uniform commodity requirements set forth here, our intention being to list only those necessary to help identify the different classifications. Your attention is also called to the fact that on the sample uniform card submitted, provisions are made for writing or stamping any special commodities the various roads might wish handled in this manner.

We would recommend that paper of such specification as will stand the elements be used, also that in application of cards sufficient tacks be used to prevent slipping or loss of card, using a minimum of three in each one.

Your attention is also called to the fact that some roads use commodity cards on open top cars, samples of same being included among those shown in our exhibit. This committee feels that the uniform commodity card presented to you can be used for this purpose by using the symbol *A* for sand, gravel, powdered coal, etc.; symbol *B* for lumber, steel, pipe and similar commodities and additional symbols as might be required, this of course to be at the discretion of the individual roads.

Discussion also brought out that several roads seal or wire the doors of empty cars at the time of classification to prevent contamination or damage to equipment before cars are placed for loading and it would be our recommendation that this be brought to the attention of the freight claim division for such handling as they deem necessary.

The uniform commodity card and uniform commodity requirements set forth here are hereby submitted to you for approval and submission to the Association of American Railroads for adoption.

The Contaminated Car

Deviating somewhat from the assigned subjects, but in line with many requests received your committee felt that a part of this report should be devoted to the contaminated car. An effort was made to frame something to place the responsibility with the offending road; but after much discussion in a joint meeting held with Committee No. 7 (Interchange & Billing for Car Repairs), it was agreed that the fundamentals for perfecting an arrangement must necessarily be inaugurated by the transportation people. Suggestion was made that waybills of cars loaded with contaminating commodities be stamped by the agent at loading points to show such contamination and that the responsibility for having such cars cleaned before being reloaded be placed with the agent at the unloading point. If and when

such a plan is put into effect whereby we of the mechanical department will be in a position to definitely know the line originating cars loaded with contaminating products such as those shown in Circular Letter of the Chairman, Car Service Department, A. A. R., dated October 27, 1930, then we believe that appropriate additions to the A. A. R. Interchange Rules can be recommended with the thought of placing the responsibility with the loading line for the cost of reconditioning such cars, where such reconditioning involves repairs to the car to restore it to its former classification.

This committee is still of the opinion, however, that a joint meeting between representatives of this organization, the Freight Claim Division and the American Association of Railroad Supervisors will be necessary before such additions to the interchange rules can be formulated and made effective.

The report was presented by Chairman H. E. Wagner, general car foreman, Missouri Pacific, Dupo, Ill.

Discussion

G. R. Andersen, district supervisor car maintenance, C. & N. W., said that the commodity card recommended in the committee's report is a definite step in the right direction, but raised a question regarding the size of the printing.

Joe Marshall, special representative, A. A. R., Freight Claim division, said that he was much interested in the committee's report because of the possibility of reducing freight claim payments by adoption of some of the committee's recommendations. Mr. Marshall said that freight damage is caused not alone by defective cars, but by contaminated cars, and mentioned several instances of damages, in one of which five cars of wheat, previously loaded with soda ash not completely cleaned from behind the lining, were moved to an elevator and unloaded in a bin which already contained 11 carloads. The entire bin of grain was contaminated by the soda ash and a damage claim of $22,500 was paid. In another instance, a car loaded with arsenic was subsequently used for the transportation of oats which were fed to horses and killed nine of them. Mr. Marshall thought it would be a fine idea to mark the waybills of cars loaded with contaminating commodities and hold the unloading point responsible for cleaning.

C. J. Nelson, superintendent, Chicago Car Interchange Bureau, made six motions, which were seconded and adopted as follows: (1) That the report be accepted; (2) that the proposed commodity card be submitted to the A. A. R., Mechanical Division, for possible adoption as standard practice; (3) that if and when approved by the A. A. R., the use of this card be made mandatory after a reasonable time to exhaust the supply of cards on hand; (4) that, if approved, the A. A. R. include specifications covering the kind of paper and printing; (5) that the present exhibit be turned over to the Mechanical Division for educational and display purposes; (6) that the association express its appreciation to the committee headed by Chairman Wagner and also to the chief mechanical officer of the Missouri Pacific, without whose co-operation this valuable report could not have been prepared.

Interchange and Billing for Car Repairs

At the outset we wish to make it clear that this is truly a Committee report, that while we have had but one opportunity of meeting, which meeting was held at St. Louis, June 17 and 18, and at which every member of the committee was present, we have corresponded throughout the year, every committee member promptly passing his opinion on the many questions submitted.

Many cases have been considered, the subject matter of which does not appear herein. Each has been given careful consideration and, for the purpose of brevity, only those that, in our opinion, justified recommended rule changes are included.

Rule 4, Par. (d).—Revise completely to read: "Other house cars.—When more than four boards of sheathing are split or broken, or when raked into tongue." (No change in Notes.)

Reason: A study develops that passage of cars through large interchange points is being seriously hampered as a result of car inspectors consuming time to thoroughly inspect cars for protection for minor delivering line defects. The need for more rapid movement is apparent. Study further develops that in the majority of cases involving such minor damage the repairs are not made until cars pass through shops on regular shopping schedule. There is, therefore, no reason why such minor damage should not be absorbed as deterioration the same as other owners' conditions existing on the car.

Rule 4, Sec. (g), Par. (3).—Revise completely to read: "Defect cards shall not be required for the following damage when not directly associated with other delivering line defects: (a) Push pole pockets—all cars; (b) Side door fixtures attached to door of car body—House cars."

Reason: Revision in this rule is desirable to provide the car owner be responsible for damage to side door fixtures when not directly associated with other delivering line damage, as these items can be, and often are, damaged in fair usage. The need for this change to eliminate unjustified defect carding against delivering line has been brought to the attention of this committee many times during the past few years, and a similar recommendation was made last year. The urgent necessity for action on this recommendation is again stressed.

Rule 19.—Eliminate last two items. Add a new item reading: "Wheels condemnable as per Rules 82 and 83."

Reason: Present rule prohibits application of certain condemned cast iron wheels, such as those which have been condemned for out-of-round and reclaimed by grinding. It is felt that this rule should also prohibit application of wheels condemned by remount limits.

Rule 32, Sec. (b).—Eliminate the phrase reading: "Or failure to properly control moving cars with car retarding device." Eliminate the first Note.

Reason: Cars damaged on a manual hump are handling line's responsibility only when damaged to the extent of Rule 44, in accordance with the provisions of Section (d) of Rule 32, and it is felt that the same protection should be extended to lines having retarder equipped humps. When car has minor damage such as a broken coupler after handling on a retarder device hump, the circumstances must be investigated to determine that there was no failure to properly handle car with retarding device. Progressive lines are thereby penalized for facility improvement. Actual study discloses that there is less equipment damaged on a retarder equipped hump than on a manual hump.

A. A. R. Billing Rules

Rule 9.—Add a new paragraph to read: "When brake beams, spring planks, wheels or truck bolsters are R&R or R, repair card must show whether or not truck is equipped with bottom rod or brake beam safety supports of any type, and (if so equipped) whether or not such supports were R&R or R."

Add additional item to Section "Brake beams R&R." to read: "Whether or not equipped with removable chair casting and (if so equipped) whether such castings were R&R or R."

Reason: To facilitate reference and coincide with Rule 17 Int. (B-5) and (B-8).

Rule 17, Int. (C-2).—Eliminate portion of second paragraph of answer reading as follows: "Except such non-AAR standard cast steel yoke and key and coupler body, if not defective, shall be held and promptly reported to car owner for disposition. If car owner elects to have such yoke and key and body returned, shipping instructions must be furnished within thirty days, and freight charges collect; otherwise such yoke and key and body may be treated as scrap."

Reason: Experience has shown that owners very rarely request return of this material, and as it is not AAR standard, and of no use to the repairing line, it is not felt that the cars and handling, as now required by this interpretation is justified.

Rule 87 (a).—Add additional item to the third sentence wherein is listed items for which counter bill is prohibited if not corrected within nine months from date of first receipt of car on home

* It should be clearly understood that the recommendations made in this report are intended for submission to the A. A. R., Mechanical Division, and are in no way authoritative or effective until duly considered and favorably acted on by that body.

line, or on any line within twelve months, from date of repairs: "Brake levers."

Reason: Claim for improper repairs are being made more than one year after application, and it is felt that if the brake levers are not replaced within one year, owner has received good value for repairs made and no claim is justified.

Rule 101.—Delete Item 52. Delete the words "or convertible type" from Item 54-A. Add the words "or non-convertible type" to Item 56.

Reason: Item 57-T of Rule 101 specifies that credit per Item 54-B of Rule 101 is to be allowed for convertible or non-convertible type triple valves regardless of the condition of the body. Item 57-F, 57-G, 57-K and 57-L of Rule 101 show that the valve of convertible or non-convertible type triple valve applied is the same as the value of either of these types removed. There is consequently no need for separate prices to be quoted in Rule 101 for the bodies of such valves, as shown in present Items 52 and 54-A. The revision of Item 56 of Rule 101 is recommended to render this Item consistent with Items 57-K, 57-L and 57-M of Rule 101.

Rule 107 (Item 166).—In the first note to this item clarify: "Sill splices on ordinary steel underframe cars."

Reason: There is confliction of opinion as to whether this phrase intends that arbitrary labor allowances shown in Items 168, 169, 195 and 200 will apply to splicing steel sills or whether it applies to splicing wood sills only on cars which are equipped with both wood underframe and steel underframe. The allowances in these items do not cover the cost of splicing metal sills equitably.

Rule 111.—Delete Item 6.

Reason: Already covered by Item 114 of Rule 107.

The sub-committee on billing for car repairs was assigned the special task of submitting recommendations for the improvement of the Index to the A. A. R. Interchange Rules, and interim report is attached hereto. The recommended revision is confined almost entirely to adding additional rule numbers to existing items in the Index where such rules appear pertinent to such items. The addition of a section covering coupler yokes under the heading "Yokes" is a recommended form in which it is believed that the Index would cover individual parts of cars more advantageously than is the case at present. If this form is approved by the A. A. R. the committee hopes to be in a position to present a completely revised Index next year.

The sub-committee was also requested to prepare a recodification of Rule 98. Our report this year is confined to recommendations for the deletion of certain items in this rule and the transfer of one item to another rule. Substantial work has been done in connection with setting this rule up in a form which would correlate matters pertinent to each other more advantageously, however, as the work has not progressed to the point that a complete report can be made at this time, the subject is being continued on the docket and it is expected that a recoded rule can be submitted at the next convention.

While meeting at St. Louis, a joint meeting was held with Committee No. 6, Freight Car Inspection and Preparation for Commodity Loading, for the purpose of discussing and placing of responsibility for damage to cars as the result of being loaded with contaminating commodities.

It was agreed that the fundamentals for perfecting a suitable arrangement must necessarily be inaugurated by the transportation department; it being our thought that way-bills of cars loaded with contaminating commodities should be stamped by the agent at loading point and the responsibility for having car cleaned should be placed with the agent at unloading point.

If, and when, some such plan is placed in effect whereby we of the mechanical department will be in a position to know what cars have been loaded with contaminating commodities and where they have been loaded, we will recommend appropriate additions to the A. A. R. Interchange Rules with the thought of placing responsibility for the cost of reconditioning high class cars, restoring them to their former loading classification, at the expense of the loading line.

Numerous instances have been brought to our attention wherein extensive damage has been caused by unloading machines coming in contact with the interior of cars, and the responsibility for such damage was not assumed by the handling line as intended by Interpretation (4) of Rule 32.

While this committee recommends no change in this interpretation, it does recommend that railroads on whose property such damage occurs assume full responsibility for such damage and attach their defect card to the car as per Rule 4, Par. (a), and failing to do so, they be more consistent in conducting investigations to determine whether or not such damage occurred while cars were in their account, when later presented with joint statements, assuming the expense of repairs, if after an honest investigation the damage unquestionably occurred on their line.

Repairing lines are being called upon in numerous cases to reimburse car owner on the basis of intermediate line's billing repair cards in connection with improper brake beams where, for example, the original repairing line indicated a No. 15 beam applied whereas the intermediate line reports a No. 2 plus beam removed. In many of these cases it was developed that the original repairing line had no stock of No. 2 plus beams, and consequently could not have applied the improper beam as claimed. It is, therefore, felt that sufficient care is not being taken in reporting correct information to show the type and location of brake beams applied and removed. This committee, therefore, requests all to take more care in proper compilation of billing repair cards to the end that this condition may be eliminated.

We wish to bring before this association the need for minimizing defect carding, lessening the time now required for car inspectors to inspect cars, particularly at the larger interchange points. This, of course, will have to be accomplished through the reclassification of defects, assessing the car owner with many defects that are now the responsibility of the delivering line under the interchange rules, and with the thought that some definite action can be taken in this regard at the next convention, we urge the members, railroad and private line alike, to write us making suggestions as to what, in their opinion, should be done.

That part of the committee report pertaining to car interchange rules was presented by Chairman E. G. Bishop, general foreman, car department, Illinois Central, Centralia, Ill., and the section on Billing by Assistant Chairman D. E. Bell, A. A. R. instructor, Canadian National, Winnipeg, Man., Canada.

(The report was accepted practically without discussion.)

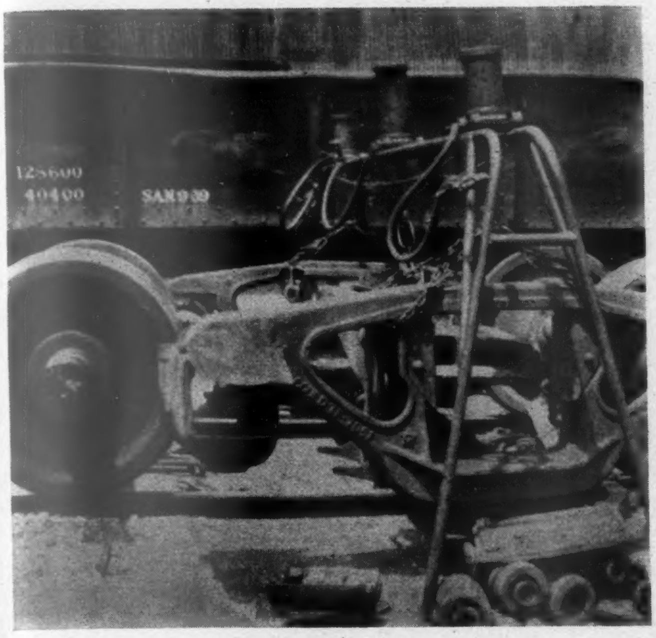
Shop Operation, Facilities and Tools

As the subject indicates, we shall endeavor to bring to you a description of various car shop devices which may be adaptable in many of your car shops, with a brief explanation of their operation.

It is a recognized fact that the membership of our organization is thoroughly familiar with the use and value of standard manufactured car shop equipment and we will make no attempt to discuss it here as it is well advertised to all concerned. Therefore, our report will be confined to home-made devices which have been designed and built to meet the particular requirements and to solve the problems of individual car shops on the various railroads.

Through the years, this subject has been much talked and written about in a piecemeal fashion, but, insofar as we are able to develop, no concerted effort has ever been made to consolidate ideas and information in regard to home-made car shop devices and make them available to all. Therefore, the Car Department Officers' Association will be the first to bring this matter to the fore in a definite report with the thought in mind that the membership will reap the benefits. When we take into consideration the multitude of car shops which are scattered all over the United States, Canada and Mexico, we begin to realize the scope and possibilities of this study.

Both large and small shops have developed numerous devices to speed up production, reduce personal injury hazards, and, last but not least by any means, to extend the efficient working life



Group 1 (A)—Portable truck repair hoist

of the trained employee. With the slow turn-over of labor in recent years, the ability to obtain experienced new men has presented a serious problem. Adequate shop facilities have helped considerably to handle the work under these adverse conditions. With the present emergency, brought about by nation-wide defense preparations, car shop forces will be pressed to the limit to keep car equipment in condition for constant service. It is readily apparent that the better and more complete our facilities are, the easier will be the task.

In conjunction with our report, we have procured photographs of several units which will be reproduced in the annual minutes. It will be appreciated that photographs or drawings of all the devices hereinafter described, would require excessive space and we have endeavored to select those which are best illustrated in this manner.

Group 1—Truck Repairs Hoists

Hoists designed to facilitate repairs to unit type freight car trucks.

Group 2 (A)—Brake beam head welding jig

(A) Portable hoist which consists of a framework constructed of angles, pipe or T-sections or combinations of all three. This unit sets over the truck to be dismantled and can be equipped with light chain hoists, square thread turnbuckles or air cylinders to raise and lower the truck side frames and bolsters. The illustration shows a hoist equipped with air cylinders. This is a new idea and two distinct advantages are claimed for it, i.e., the maximum speed of operation and, due to cylinders being mounted on top of frame, it is lower and better balanced for movement from one location to another; (B) Permanent truck hoist, single or double—jib type, (see Fig. 7 Page 31, January, 1940, *Railway Mechanical Engineer*) for installation where cars are moved to established Spot positions for truck repairs. This type of hoist requires a good foundation, preferably of concrete, for the vertical post. The frame of jib swings to a parallel position with the track when not in use. The same type of equipment is used for raising and lowering truck sides and bolsters as with the portable unit; (C) Permanent truck hoist, collapsible type, for Spot position installation (See Fig. 6, Page 30, January, 1940, *Railway Mechanical Engineer*). This unit is equipped with a counterweight at one end and, when not in use, may be raised to a vertical position requiring a minimum of space. Other equipment is the same as on the two units previously described.

Group 2 (B)—Brake head grinding machine

Many car shops have been equipped with truck hoists for some time and the use of these devices alone have made it possible to cut the time in half; or even less, on wheel renewals and other truck repairs. Furthermore, their use has practically eliminated damage to journals which previously resulted in connection with the removal and application of truck side frames when trucks were dismantled for repairs.

Group 2—Brake Beam Head Reclamation Jigs

(A) The welding jig. This unit is used to hold the brake head in firm position while checking for wear and building up by welding to restore the original dimensions. It will be noted from the illustration that the machine is equipped with a foot pedal which is used to bring the upper portion of the jig down on the brake head for gaging after which small metal shims are tack welded on the work surfaces to reduce the amount of welding material necessary to apply. The welding is completed after the

brake head is removed from the jig; (B) The brake head grinding jig. After the brake head has been built up by welding, it is placed in this machine and ground to the proper radius for the brake shoe fit. The grinder is air operated and the brake head is held rigid while grinding with the foot pedal as shown in the illustration.

Brake beam heads are an important factor in the repair cost

Group 3 (B)—Device for straightening freight car ends

of reclaimed brake beams. Tests have developed that they can be built up by welding successfully if proper care is exercised in the selection of welding rods and he welding machine amperage is accurately regulated for this type of work. It has been stated that the reclamation if brake heads by welding costs approximately one half as much as the purchase price of new brake heads.

Group 3—Miscellaneous Devices

(A) Journal box packing mixer (See Page 371, September, 1941, *Railway Mechanical Engineer*). The operation of this unit can best be described by comparing it to a concrete mixer, except that the revolving speed of the drum is much slower. The drum is about five feet in diameter and has an opening at either end, one to put the packing into and the other to remove it from after

Group 3 (C) All-purpose light-repair-track truck

Group 3 (D)—Device for applying draft gears

mixing. The turning of the drum is accomplished with a three horsepower electric motor mounted on top of the framework which has a sprocket chain drive to the drum. The illustration is self explanatory in regard to the construction.

The saturation of journal box packing is an important factor in obtaining proper lubrication of freight car journals. It is claimed that this device keeps the packing evenly and thoroughly mixed until it is ready for application to the journal box. It eliminates the necessity of pumping oil over the packing at frequent intervals. In fact, the packing is taken from the shipping containers and placed directly into the mixer as required for daily use. This saves considerable time and labor in handling.

(B) Device for straightening ends of freight cars. This unit is built up of angles, channels, a ½-ton chain hoist, an air jack, a straight shank car coupler, etc. It is designed for use with an overhead or locomotive crane which is necessary to move it from one location to another. The illustration indicates how the unit is assembled and how it functions in service.

Group 3 (E)—Air wrench for use in bolting car floors

Straightening ends of freight cars without removing the sheets, stiffeners, etc., has always presented a difficult problem on the light repair tracks. The use of pull jacks and other similar devices are not only dangerous, but their capacity is limited. The machine which we have described has been in service but a very short time but it has proven very satisfactory. It is particularly well adapted to straightening the ends of steel gondola cars and this work can be accomplished in a very short time as compared with other methods.

(C) An all-purpose truck for light-repair-track service. A compact and well equipped unit which includes riveting equipment, car jacks, trestles, acetylene cutting outfit, etc. The details of the assembly are clearly shown in the illustration. The frame of the truck is of lightweight pipe construction, covered by a metal platform and has an equipment box under the platform for small tools, bolts, rivets, etc.

This all-purpose truck carries all the equipment required by a light-repair gang to make repairs to trucks, couplers, etc. Pneumatic tires, wire wheels and lightweight construction make it easy to move from one location to another and it saves considerable time which would be consumed in moving equipment one piece at a time.

(D) Device for applying draft gears to cars equipped with horizontal coupler yokes. The frame of this unit is 9¾ in. wide and 6 ft. long, constructed of two 2-in. by 2¼-in side angles welded together at the ends to cross-members of the same material. At the upper end, curved angles are welded to the side of the frame to form a track which raises the draft gear carriage and sets it in nearly a horizontal position so the draft gear may be pushed over the draft gear support. The upper end of the frame has two brackets which set on the axle of the outside pair of wheels and these are adjustable for height desired with variation in wheel diameters. The draft gear is placed on the carriage at the bottom of the frame and pulled to the top of the curved track by means of a small hand wrench which is equipped with a rachet pawl for safety. The illustration shows the position of draft gear before it has been raised for application.

This device fills a long felt need for a method to apply heavy-duty draft gears on cars equipped with horizontal yokes. Raising draft gears to position with jacks, levers and similar methods is a difficult and unsafe task.

(E) Air wrench for use in bolting car floors. This device consists of an air-motor wrench secured to a platform equipped with three swivel type wheels and a metal tray at one end for supply of nuts. The wrench has a telescoping shaft with the socket on the upper end readily adaptable to variation of floor heights without any adjustment. The operator sits on the platform and propels the unit around under the car with very little effort.

Applying nuts to bolts of car floors with an ordinary hand or motor wrench is a tiresome job and this device makes it much easier for the workman and speeds up the job.

In our study of "home-made" car shop devices, we have developed considerable information and data relative to many other items of equipment. To include all of this detail would involve a voluminous report. We will therefore only mention a few of them which no doubt will be of interest to many. They are as follows:

(1) Car trestles constructed of pipe and scrap boiler plate, welded to provide maximum strength. These are made up in many different types for particular requirements. They are simple in construction and far superior to wooden trestles in safety and economy of maintenance; (2) A wheel base gage designed for mating unit type truck side frames in reclamation shops. Proper mating of truck side frames is an important factor in extending the life of wheels and other truck parts; (3) A combination truck bolster and body side bearing which makes it possible to accurately determine the side bearing clearance in advance of application of truck to car; (4) Portable lumber paint spray machine designed for painting lumber when unloaded at central distribution points. Surplus paint is removed from lumber as it is taken from the machine and returned to the supply tank through a filter. This reduces the consumption of paint to a minimum in this operation.

It is the unanimous opinion of your committee that the opportunity for further study in this field has great and valuable possibilities. In this report we have scarcely touched the surface, and, we heartily recommend that the work of Committee No. 3 be continued at least for another year in the study of home-made car shop devices. We also suggest that the membership be invited and encouraged to submit material for future consideration. It is impossible for the committee to cover the territory which should be investigated and we are certain that there are many devices which should be made available to us.

In conclusion, we desire to extend our sincere thanks to those who were not members of the committee, for their many fine suggestions and counsel. We earnestly hope that what we have brought to you will be of benefit to the association and its membership and we assure you it was a pleasure to serve in this capacity.

The report was signed by R. K. Betts (chairman), foreman car repairs, Pennsylvania, E. St. Louis, Ill.; C. A. Jordan, general car inspector, N. Y. C. & St. L., Cleveland, Ohio; W. J. McCloskey, general car foreman, Illinois Central, Centralia, Ill.; R. P. Dollard, shop engineer, C. & O., Richmond, Va.; P. B. Rogers, shop superintendent, A. T. & S. F., Chicago; H. S. Keppelman, superintendent car department, Reading, Reading, Pa.; E. P. Marsh, assistant superintendent car department, C. & N. W.; and A. Herbster, general foreman, N. Y. C., Chicago.

Discussion

P. P. Barthelemy, master car builder, G. N., said that car shop supervisors should insist on the use of new material for steel ladders, car trestles, etc., in the interest of safety and Chairman Betts agreed that scrap material if applied should be carefully selected to make sure that the sections are corroded slightly, if at all, and have practically the equivalent of new strength. Mr. Barthelemy stressed the use of all possible labor-saving devices to take the manual lifting out of car work, in the interest of safety and increased production.

F. J. Swanson, general car department supervisor, C. M. St. P. & P., Chicago, pointed to the great advantage of concrete roadways at light repair track which make possible the use of lift trucks, enabling four men, for example, to apply 24 pairs of car wheels in eight hours, whereas by the older method, it was a good day's work for one gang to apply 8 to 10 pairs of wheels.

Chairman Betts said that everyone appreciates the value of concrete runways and tractors, but that the expenditure involved is not justified at outlying points where possibly only 10 car men are employed. He said that the labor-saving devices recommended in the committee's report are designed to take some of the manual labor out of car work at these small repair points.

D. J. Sheehan, superintendent motive power, C. & E. I., strongly urged the car men to back up their requests for new equipment and tools with specific information regarding the savings anticipated. He said that car men can get the authority to buy these tools if it is really shown that they will earn their salt. He maintained that extensive improvements in car repair facilities cannot usually be effected overnight and that it is usually more feasible to purchase and install them one at a time.

(The report was accepted.)

Maintenance of Streamline Equipment

The advent of the streamliner train and its many diversified changes in body design, truck construction, electric-pneumatic brakes, pretentious interior finishes and fittings as compared to the conventional type of equipment presents a new problem in maintenance to the mechanical personnel of our railroads. Primary consideration is essential in selecting terminal coach yards or shops that can conveniently track or house the equipment during the layover servicing periods, keeping in mind as to whether or not available facilities were adequate for the specific maintenance desired, and if not, if sufficient space was available to accommodate the additional facilities required. Concrete ramp structures and inspection pits equipped with air, steam, water, electric lines and drains, modern electric drop tables and hoists for the removal and application of wheels and trucks complete, machine shops, wheel turning and grinding lathes, electric arc welding machines, electric charging lines of high voltage, power jacks, drill presses, special electric and pneumatic hand tools, to say nothing of the large space required to house stock material were some of the facilities necessary. The next important step is to select supervisors and mechanics who were intellectual, progressive and best qualified to cope with the class of maintenance desired. As a matter of fact a careful selection must be made of the coach cleaners assigned to handle the various cleaning features in order to obtain the most exacting results.

We believe it is agreed that the general maintenance of the conventional type of passenger carrying cars is more or less

identical as amongst all railroads. To some extent, many of the past practices in cleaning and repairs are still in vogue on streamliner equipment, however, there are many added features on streamliner trains where the former practices are not adaptable. Modern and pretentious interior fittings, color schemes, truck and body design, electric-pneumatic brakes, electrical equipment, air conditioning, etc., meant that all concerned were confronted with the problem of devising ways and means of maintaining these new features as efficiently and economically as possible to do so. In addition to the general facilities and tools, consideration has to be given to the kinds of cleaning materials that would be best suited for this work and which incidentally had to be developed through tests in many instances. Railway supply companies have introduced some good cleaning materials and assisted supervisors in every way possible in meeting their various problems. Once the proper kinds of materials are agreed upon, it then becomes necessary to set up a definite schedule with respect to the work that would be performed daily and the frequency in handling of special work. This same procedure is also followed in detail in the periodical over-hauling, testing and lubrication maintenance. With this in mind, the committee has endeavored to describe the manner in which a number of the principal operations are being handled generally.

Interior Cleaning

In the cleaning of interiors, it is the practice to vacuum the shades, drapes, upholstery and carpets each trip of cars into terminals. Electrical appliances operated with the same voltage as carried in the cars, has been adopted for this use inasmuch as the operation can be performed much more rapidly than with the use of the air syphon jet system. Past experience has taught us that in using the air syphon jet system a considerable amount of time was utilized in transporting equipment, particularly the long lengths of hose, from car to car throughout the train yard. Window sills, doors and partitions became scuffed and dirtied in the handling of hose from the yard connections into the cars through the vestibules or windows. Another objectionable feature is the fact that doors or windows had to be left open for the entrance of the hose and consequently flies and other insects entered the interiors and which of course necessitated additional labor in ridding the interiors of these pests after the vacuuming operation was completed.

Further, too much time was lost in connecting and dis-connecting hose each time that the car involved was moved. Spots and stains are removed each trip with a proficient cleaning fluid. When drapes become dirty they are removed for dry cleaning, a complete set of substitute drapes being available for this purpose. Window shades, upholstered seat cushions and backs are washed periodically with a shampoo with sufficient time being allowed for drying in advance of the scheduled departure. Carpets are removed from cars at least once every sixty days and placed on a blow rack platform for a thorough cleaning with compressed air and followed by shampooing. The shampoo referred to is a liquid material which is proportionately mixed with water and forms a foam or sud solution. This sud solution is applied to shades, upholstery or carpets with a sponge and rubbing vigorously. An additional pail of water is used for the frequent rinsing of sponge and removal of dirt. Rinsing water should be kept fairly clean at all times. After cleaning, blowing with compressed air will assist in drying the materials more rapidly and which of course is important where this work is performed on equipment with a short layover period.

As an extra precaution against unnecessary soiling as well as adding to the life of carpeting it is the practice to furnish each car with a canvas aisle strip. Attendants are required to lay these canvas aisle strips on the floor immediately after passengers have been discharged upon arrival of trains at the passenger terminals. Once the cars are cleaned at the coach yards, canvas strips are again laid on carpeted floors and not taken up until just prior to loading time at the passenger terminals.

The same precaution is taken to protect upholstery, particularly the seat arms adjacent to the aisles, by covering with canvas caps. In this manner the upholstered seat arms are not dirtied by the mechanics' overalls as they pass through cars in performance of their servicing work.

Sheet cork, wall paper, photo-murals and the leather pier panels, chairs and shelving are dusted or dry wiped each trip. Periodically, sheet cork is cleaned with naphtha and then given a light coating of lacquer. Wall paper and photo-murals are washed with a soap sud solution, using a good grade of castile soap in lukewarm water and after drying the surface is given a thin coat of lacquer. The application of lacquer serves to protect that finish and extends the duration of time as between subsequent cleanings. Leather is also washed with a good grade of castile soap and water, cheesecloth being preferable for this use. Under no circumstances should polish, oil or ammonia ever be used.

In cleaning (mopping) rubber tiling with inlaid patterns and cemented to a cork flooring it is imperative that a minimum amount of water is used and then removed as quickly as possible. Where an excess amount of water is used and same is allowed to remain on the tiling for a length of time it will work through the cork, pulverizing same and causing the tiling to bulge. This is a matter for builders to consider in future installations.

Painted ceilings, walls, partitions, doors, baggage racks and vestibules are dusted or dry wiped each trip, the scuff marks and spots being removed with a wax dampened cloth. These painted surfaces are being waxed progressively so that each car interior is waxed complete once every ninety days. The waxing operation is confined to certain efficient male cleaners who are thoroughly familiar with its application. A better grade of work is realized in this manner than if the waxing operation was left up to the individual interior cleaners who work in the various cars. An allotted number of hours labor is devoted to this operation daily with a sufficient amount of time remaining in advance of scheduled departure to take care of the removal of handmarks and baggage scuffs that are always prevalent on vestibules, doors, partitions and side walls. In maintaining the painted surfaces with wax it has been proven over a period of time that the finish still retains its original lustre, whereas this cannot be said of the painted surfaces where soap and water have been used. It is a known fact that the repeated use of soap on painted surfaces will ultimately deteriorate the finish and to the extent that repainting becomes necessary.

Multi-vent ceilings or panels are removed for the blowing and cleaning of air ducts semi-annually. After re-applying it is necessary to clean with wax. Where this type of ceiling is used in lounge cars or the smoking rooms of parlor and coaches, the constant presence of smoke results in ceiling panels becoming stained with a yellow color resembling nicotine around the perforations and which can be removed with a wax dampened cloth if attended to frequently. In the absence of frequent attention, waxing proves of no avail and spray painting is required.

Smokestands—we are all familiar with the proper procedure to follow in their cleaning, however we might add that in order to assist in eliminating the objectionable stagnant smoke odors that it is a good practice to remove the ash receptacles from the smokestands for cleaning immediately upon arrival of equipment at the coach yards.

The cleaning of lavatories, windows, basket racks, lighting fixtures and the kitchens and pantries are still maintained in somewhat the same manner as on conventional equipment, therefore we will pass on to our next operation.

Exterior Cleaning

Generally, exteriors are given a plain water wash daily. Periodically they are cleaned with materials best suited for the type of finish, whether it is varnish, lacquer or stainless steel. Green oil soap is very effective in the removal of oil, grease, tarry substances and insects. Regardless of the materials used, it goes without saying that there is a great deal more surface to wash on streamliner equipment as compared to conventional. Diaphragm rubber, skirt sheets and roofs receive the same attention as the body. Where it is the practice to wash roofs each trip of trains into terminals, portable scaffolds with guard rails are the most suitable for the performance of this work, particularly so from a safety viewpoint. These scaffolds are mounted on rubber tired wheels and can be readily moved from car to car along side of trains. In the absence of scaffolds it is found to be a very dangerous practice for men to walk on the roofs. With the prevailing roof curvatures and the fact that oil and water creates a slippery condition, men are apt to fall and become seriously injured. One railroad found that the use of scaffolds would obstruct traffic on the sidewalks adjacent to the trains and at the same time they would not sanction the practice of assigning men to work on the roofs and as an alternative it was decided not to wash the roofs daily, but to take the individual cars out of trains

at least once every ninety days and place on a track where scaffolds could be conveniently used and then scrub the roofs, followed by painting. On these same occasions the rubber diaphragms, skirt sheets and steps are painted.

Trucks were originally cleaned by spraying with a solution of mineral seal oil and kerosene and the resultant glossy effect created a very good appearance, however due to the fact that dirt adhered to the truck parts on this account and might result in concealing such defects as cracks it was proposed that another substitute be found. Some railroads then cleaned the trucks by brushing with a solution of green oil soap and water, while others used a jet system in cleaning with steam and soda solution. Both methods proved effective and left truck parts in a good clean condition and facilitated inspection and repair work. Periodically the trucks are spray painted and restencilled. During the winter month when large accumulations of ice and snow adhere to truck parts, cleaning is important to facilitate inspection and repairs. Usually it is the practice to remove large pieces of ice with a bar and followed by steaming. This procedure dislodges ice accumulations between bolsters, springs, brake levers, side bearings, etc., and will serve to eliminate hard riding complaints.

Mechanical

In dealing with some of the many phases of mechanical maintenance, it was decided that it would not be amiss to commence with inspection work. For after all, it is the inspection that is responsible for the repairs made, especially so in the maintenance of trucks, including wheels and roller bearings. Owing to the importance of this class of work every conceivable precaution is taken. Supervisors in charge of streamline maintenance, being familiar with their fast schedules, realize their responsibility for the safe and on time operation. They in turn have selected the most dependable car inspectors from their organizations for this assignment and they work together and are thoroughly conversant with every detail of maintenance and systematically outline the repairs necessary, daily and periodical. Back of this work the railroad managements have provided elevated ramp tracks and inspection pits to facilitate inspection and repair work. Due to the appurtenance that is now suspended from underneath streamline cars and concealed from view by shrouding and skirt sheets, the ramp track and inspection pit affords car inspectors the opportunity to carefully check all truck parts, brake levers, support brackets and attachments. We know of one railroad who at the present time are constructing a series of ramp tracks and inspection pits. Constructed of concrete the ramp track on which rails are installed are elevated approximately five inches higher than ground level. This height and the height of the rail facilitates inspection and repair work such as the renewal of brakeshoes, hangers, pins, the servicing of roller bearing boxes and the pressure greasing of truck parts. Inspection pits run the full length of ramp tracks and are equipped with water, air, steam and electric lines as well as drains. A series of lateral drop pits for the removal of wheels and other heavy repairs are conveniently located along each track so that several cars in any one train can be undergoing repairs at one time and still not interfere with other maintenance work. Cars are spotted with a car puller.

Repairs to streamline equipment has changed considerably as compared to conventional cars. With increased speed and the endeavor to promote good riding qualities, wheels are condemned for tread wear with special gauges. This practice varies, some railroads condemn wheels with a 7/32 in. tread wear while others remove wheels with only 5/32 in. tread wear. With these gages in use, tread wear becomes the principal defect for which wheels are removed. After wheels are turned in lathe and in order to reduce the margin of eccentricity, some railroads then grind their wheels before application. Stabilizing levels, bolster draft rods, shock absorbers and additional equalizer and bolster springs results in additional maintenance. These parts must be kept in good repair and adjustment to assure good riding qualities. In the absence of ramp tracks with inspection pits, cars are arbitrarily cut out of trains periodically for careful inspection on the regular repair tracks. Terminals handling special work make it a point to thoroughly check and repair trucks periodically, as a matter of fact, complete repaired trucks are substituted as required. Semiannually the trucks and all parts are thoroughly cleaned with kerosense for a hammer test. Due to high speed and the road ballast gradually wearing and having a sandblasting effect on truck parts, metal cross members, steam regulators, etc., it is found necessary to insulate and shield numerous parts. Some equipment has underneath parts sprayed with a rubber cement as often as once every thirty days to alleviate the condition already mentioned. Vertical or flanged tie bars have been introduced and applied to pedestals to prevent the slewing of trucks in the event of a derailment.

Roller bearings, regardless of manufacture, are generally given the same attention at all terminals. Upon arrival of trains the boxes are felt with the bare hand to determine abnormal temperatures. Oil plugs are removed and the oil levels checked, adding oil as required. Where boxes are found operating above normal temperature, the oil discolored, etc., wheels are immediately removed for a complete check of all roller bearing parts. Semiannually the covers are removed for inspection of boxes and the furnishing of Summer or Winter oil. On each occasion that wheels are changed, boxes are completely dismantled for inspection, replacing with new the worn or defective parts found. Originally these boxes were equipped with heat indicators or commonly termed stench bombs that would throw off an obnoxious odor to warn members of train crews if boxes were operating at an abnormal temperature. This method has been improved upon inasmuch as recently built equipment have an electrically controlled signal alarm system connected to each box and when excessive heat develops, it is so indicated in the car interiors.

Lubrication is another matter receiving more attention on streamline equipment. Using air pressure guns, center plates, pedestal liners, slack adjusters and other truck parts are carefully lubricated each trip, and all of which results in reducing wear and improving the riding qualities of equipment.

Air Brakes — Air-Conditioning — Electrical

The introduction of the electric-pneumatic brake have resulted in many changes in our former practices. This class of maintenance meant that mechanics had to be trained and which was done with the assistance of representatives of the air brake companies. Special test racks and test trucks for the testing of valves electrically and pneumatically had to be installed. The added number of brake cylinders, control valves, magnet valves, relay valves, E-3 brake application valves, K-3 switches and speed governors meant more maintenance and by competent mechanics. Testing, cleaning, oiling and repairing schedules, daily and periodically, are strictly adhered to.

It is needless for us to talk about this maintenance as all phases of the operation was ably covered by the Passenger Train Car Handling Committee at our meeting last Fall.

This class of maintenance has increased tremendously due to the additional amount of modern electrical appliances and conveniences now carried in streamline equipment. Additional lighting facilities, water coolers, exhaust fans, shaving receptacles, refrigerators, radios, telephones, speedometers, and back-up horns are some of the added new features and requiring daily attention as well as periodical overhauling.

Will not attempt to relate the amount of daily and periodical attention that is afforded such items as couplers, draft gears, water pressure systems, steam regulators, metallic conduits, etc.

In many instances, work is progressively carried on as between two terminals, therefore work sheets are carried on each train to indicate the work performed, enabling one terminal to pick up where the other left off. Trip inspection reports are also carried in each train for electricians, conductors, and porters to report any unsatisfactory condition occurring enroute and requiring attention.

Work cards are carried in each car to indicate the special work that is required periodically, entries being made on cards accordingly. In this manner, supervisors handling streamline trains have first hand knowledge of the work needing their attention.

Our study developed that the same definite program is followed in the daily and periodical servicing of the power units and auxiliary cars, however in order to keep within the time limit allotted for the presentation of our subject we regret being unable to cover the vast amount of detailed precision work that is required in the maintenance of main engines, traction motors, steam generators, AC and train lighting auxiliaries, air brakes, etc., of these units, but owing to the extreme importance of this class of maintenance we are respectfully recommending to the General Committee that this subject be reviewed at our next meeting.

(Continued on page 433)

A Quarter More Use From Lo

A. A. Raymond,
President

The Railway Fuel and Traveling Engineers' Association report on Utilization of Motive Power outlines methods for accomplishing such an increase—Diesel locomotive operation and air brakes among other subjects discussed at Chicago

At its fifth annual meeting, held at the Hotel Sherman, Chicago, on September 23 and 24, the Railway Fuel and Traveling Engineers' Association presented and discussed a program which by rigid adherence to a time schedule was completed within the allotted two days. Although somewhat curtailed by the enforcement of the schedule, the discussions were brisk and gained in pointedness what they lost in length.

Following the adjournment of the joint opening session of the four coordinated associations, the first session of this association was called to order by its president, A. A. Raymond, superintendent fuel and locomotive performance, N. Y. C. In his opening remarks, Mr. Raymond said that conferences such as this were needed more now than at any time before because of the unusual problems with which railway supervisory forces are faced. These, in part, he said, are the outgrowth of the battle of materials resulting from the tremendous volume of materials and equipment required for our national defense program.

Mr. Raymond briefly reviewed the program for the meeting, pointing out the large amount of work which has been done by the various committees. The best repayment to these men for their effort, he said, would be a good discussion of the reports.

The program was built around three major themes—locomotive performance, including both Diesel and steam; fuel, and air brakes. The greater number of reports were devoted to the steam locomotive, with a new Committee on Lubrication reporting for the first time this year. In addition to the reports and papers abstracted herewith, this session included a report on New Locomotive Economy Devices. The chairman, A. G. Hoppe, assistant mechanical engineer, C. M. St. P. & P., briefly reviewed the performance of the Franklin system of

L. E. Dix,
Vice-President

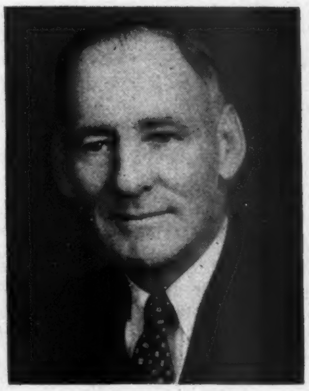
T. Duff Smith,
Sec.-Treas.

steam distribution with the OC poppet valve and also called attention to the automatic draft control in service on the Lehigh Valley.

The second session was set aside exclusively for the discussion of air-brake subjects, under the chairmanship of J. A. Burke, supervisor air brakes, A. T. & S. F., who introduced the authors of the three air-brake papers.

A report on Plugged Netting—Cause and Cure was presented by a committee, of which H. Malette, road

Locomotives Suggested


W. C. Shove,
Vice-President


J. A. Burke,
Vice-President

foreman of equipment, St. L.-S. F., was chairman. This will be the subject of an article in a subsequent issue.

During the meeting the association was addressed briefly by John M. Hall, director, Bureau of Locomotive Inspection, I. C. C., and Roy V. Wright, editor, *Railway Mechanical Engineer*.

Address by J. M. Hall

In a brief address, J. M. Hall, director, Bureau of Locomotive Inspection, I. C. C., spoke in terms of the higher praise of the performance of the mechanical and operating departments during the present time of stress. At the beginning of the last war, he said, 54.5 per cent of the locomotives inspected by the bureau were found defective, while now only 9 per cent of the locomotives inspected are found to be defective. That, he suggested, is one reason why trains now keep moving with so few delays.

Mr. Hall cited figures to show the tremendous improvement in locomotive conditions as reflected by the reduction in accidents and casualties caused by the failures of locomotive parts since 1916. The safe machine, he said, has proved to be the good machine. Along with the reduction in failures has gone a reduction in the cost of boiler maintenance and in fuel consumption. Except where caused by hidden defects, Mr. Hall said, there never should be a boiler explosion and there never would be if maintenance and operating forces were all awake. In closing, Mr. Hall said that the traveling engineer can do much through his personal contact with the engineman to overcome the opposition on the part of some of them to the operation of the blow-off cock required in the blow-down system of preventing foaming.

Remarks by Roy V. Wright

Mr. Wright, called upon during the meeting, spoke briefly concerning the situation of the railroads in the national defense program, calling attention particularly to the needs for material and equipment. They were making good, he said, by mobilizing their man power and he stressed the possibilities offered by making better use of the human element. He cited one example of this as the prevention of accidents. He quoted the National Safety Council's estimate that for 1941 the nation would suffer an economic loss of 3.6 billion dollars as the result of accidents. A great deal of this loss he considered preventable and stressed the need for safety campaigns as the activities of the railways increase.

The Road Foreman and the Diesel Locomotive

By W. D. Quarles

General Mechanical Instructor, Atlantic Coast Line

In December, 1939, the Atlantic Coast Line and the Florida East Coast inaugurated faster daily service between New York and Miami with our deluxe trains, "The Champion," Diesel powered between Washington and Miami, and typical of Diesel passenger operation throughout the country.

This improved service established itself so permanently in the public's favor that 19 2,000-hp. Diesel passenger units (18 Atlantic Coast Line and 1 Florida East Coast) were added to provide Diesel power for the "Vacationer," the "Florida Special" and the bigger "Champion." The original "Champion" consisted of seven light-weight cars powered with one 2,000-hp. unit; this being increased to fourteen light-weight cars and two 2,000-hp. units. The "Vacationer" and the "Florida Special" were powered with 4,000- and 6,000-hp., respectively.

As further evidence of the fine service rendered by the Diesel locomotive, the Atlantic Coast Line and the Florida East Coast now have on order twelve additional units (9 Atlantic Coast Line and 3 Florida East Coast) to Dieselize other Florida trains for the coming winter season. With the units now on hand this will give us a total of 34 passenger units, all of which have been purchased in the past two years.

We have good steam locomotives on our line but they have not been successful in their operation on high-speed trains.

No Power Failure in 2,700,000 Miles

August 1, 1941, the combined mileage of our road Diesels aggregated 2,704,000 miles without a power failure necessitating replacement by steam, and as a consequence of this performance, we do not have stand-by protection for Diesel power.

On July 12, Train No. 2, operating between Miami and New York (mixed streamlined and conventional equipment) was wrecked at Walthourville, Georgia, due to striking and knocking a cow into a switch stand of the center passenger track. This was an opposing switch; it was opened, and both power units and seven cars were derailed. The speed of the train at the time of the accident was 75 m.p.h. The power units were rerailed and moved into our Waycross, Georgia, shops on the afternoon of July 14, where only steam facilities were available; however, the

units were conditioned and returned to service on July 18. This reference is made to indicate the sturdiness of this type of power.

We do not have Diesel freight power as yet, but one only needs to observe the service rendered where this type of power is used to determine its ability in fast-freight service.

All concede the Diesel switcher's supremacy to the steam. We have two types of Diesel switchers on our line and careful records are being kept to determine the type best suitable for future purchases.

The Diesel locomotive, at present, is used largely in the high class passenger service, where the schedules are the fastest and the service more exacting. If the road foreman desires this to be what is expected, he must spend his time with the men in order to educate and acquaint them with all phases of the operation.

Diesel-Electric Throttle Technique

The handling of the throttle of the Diesel-electric locomotive compares in no way with the handling of the steam locomotive's throttle. It is in this that the electric equipment can be subjected to severe abuse and high maintenance costs. The engineman should know what takes place in the power room when the throttle is moved from idle position to position No. 8. If the operation of the electro-pneumatic governor and load regulator is understood, no trouble is experienced from these men failing to use the proper time element between throttle positions; when accelerating or decelerating, time must be had to permit the Diesel engine to respond and assume the new speed for each throttle position. This also gives the load regulator time to balance out with the new load demand. When too much time is consumed in advancing the throttle, the traction motors stay in series longer than necessary, and as transition is delayed, several power plants may transfer at once, giving an objectional surge to the train.

In steam-locomotive operation no serious results are obtained by opening and closing (pumping) the throttle; however, if this practice is used on Diesel-electric locomotives it causes destructive arcing at series and field contactors, unnecessary wear and removal of parts and rough handling of the train.

The engineman should know that at speeds below 30 m.p.h the acceleration should be made with traction motors operating in series. If acceleration takes place with traction motors operating in parallel there will be improper application of power to the traction motors, the high amperage flow causing heating, and loss of power for acceleration.

When passing over railroad crossings the engineman should know that the vibration causes poor contacts between brushes and commutators on traction motors, which results in arcing and burning of commutators. When the throttle is in position higher than Run No. 2, the voltage and currents will be high; by reducing the position of the throttle to Run No. 2 this is minimized and the prevention of the flash-overs in the motors is assisted.

With the light-weight streamline trains having little or no slack in draft rigging, no trouble was experienced when these trains were started. However, now that Diesel-electric power is handling trains which consist of mixed streamlined and conventional equipment, or all conventional equipment, the question of throttle manipulation is of great importance, as well as the methods used in stopping trains of this make-up. The characteristic of traction motors is to develop a high torque when starting, with resultant high drawbar pull, and on runs where there are two or three power units the slack is sometimes taken out severely and rough handling occurs, especially at the rear of the trains.

The writer has found that, first, much can be done to relieve this by stopping trains with slack stretched, making one application of the brakes and using graduated methods when releasing brakes; second, where two or three power units are handling trains, one or two power plants were isolated until the train slack was stretched, or the train started. This practice eliminated the trouble in starting and slack was controlled.

Training Firemen for Road Maintenance

On our line at present we have an electrical supervisor riding all road Diesels. He is just what the name implies; he has a knowledge of the equipment not yet obtained by the crews. Firemen assigned to Diesel-electric locomotives will perform all duties in the power room necessary for correct operation, and make any repairs required, under the direction of the electrical supervisor. The electrical supervisor is subordinate to the road foreman of engines.

With this method of operation we have developed assistant road foremen, firemen instructors and firemen, who are thoroughly capable of being trusted with the care and operation of our Diesel locomotives.

The fireman of today is the engineer of tomorrow, and by hiring firemen not for their brawn, as was the case in the past, but young men with a high-school education and a natural aptitude for railroad work, we should perfect an organization for Diesel road operation which should function as well as steam operation and with the same supervision.

Discussion

Prof. L. E. Endsley said that the railroads are coming to Diesel locomotives faster and faster and that the best steam locomotive today uses six times as much fuel as the Diesel-electric locomotive. With five-cent oil, he said, the balancing price for coal would not be over $2 per ton. He prophesied that in 20 years no more steam locomotives would be purchased unless steam develops faster than he believes it will.

Mr. Wink (A. C. L.) said that it was not difficult to teach any man in 30 min. to run a Diesel-electric locomotive, but that he cannot be taught to take proper care of the engine in any such short time. The fireman, he said, on his tours every 20 or 30 min. looks after the equipment and is thus trained to know its requirements. In closing, Mr. Quarles referred to the much greater number of Diesel locomotives than of steam which have been ordered during the current year and agreed with Professor Endsley that steam is on the way out.

High-Speed Braking With D-22 Control Valves

The D-22 control valve has several improved features among which are the quick service feature; service stability; positive release regardless of service slide valve friction; improved graduated release feature; improved emergency transmission speed; improved release after emergency application; increased capacity; more uniform brake cylinder pressure; simplified construction and interchangeability with previous equipment.

Improved brake flexibility and sensitive control in the hands of the enginemen assist in the maintenance of intensive schedule, add new safeguards to operation, and the equivalent automatic cushioning of intratrain shocks are also characteristics of new passenger train brake types.

[The report included a summary of the advantages of the present electro-pneumatic braking systems with particular reference to the features which control wheel sliding. A detailed description of such equipment as applied to one of the Burlington Twin Cities Zephyrs was also included.—Editor.]

There are a number of high-speed trains being operated throughout the country with speed governor control but without wheel slide protection, and are not having much trouble with slid flat wheels, but the secret for this in most cases, is that generally only light brake applications are being used for making slow downs and stops. In most instances these light brake applications do not exceed the braking forces employed on older equipment, and as a result the motive power is called upon to maintain higher maximum speeds to offset the time lost by the brakes being applied earlier than it normally would be necessary if wheel protection were used. If, however, the maximum of 200 to 250 per cent braking forces were used in ordinary service braking, there would be a far different story, and the necessity for ample sanding with some form of wheel slide protection would be recognized at once. In our opinion these high braking forces should be available at all times without fear of damage to wheels; they can be available with the equipment now at hand.

Officers Elected for 1941-42

***President:* L. E. Dix, fuel supervisor, T. & P., Dallas, Tex.; *vice-presidents:* J. A. Burke, supervisor air brakes, A. T. & S. F., Topeka, Kans.; E. E. Ramey, fuel engineer, B. & O., Baltimore, Md.; W. C. Shove, general road foreman of engines, N. Y. N. H. & H., New Haven, Conn.; *secretary-treasurer:* T. Duff Smith, Railway Fuel & Traveling Engineers' Association. *Executive Committee—elected to serve 2 years:* E. Holmquist, master mechanic, C. & N. W., Chicago; A. G. Hoppe, assistant mechanical engineer, C. M. St. P. & P., Milwaukee, Wis.; H. W. Sefton, superintendent locomotive and fuel performance, C. C. C. & St. L., Indianapolis, Ind., and W. R. Sugg, superintendent, fuel conservation, Mo. Pac., St. Louis, Mo.**

For service braking the use of electric straight air brake is of prime importance on fast schedules, as the brakes can be applied throughout any length of train to the desired brake cylinder pressure in two to four seconds, depending on just how fast it is desired to build up the pressure; this depends on passenger comfort and the liability of sliding wheels.

The handling of the brakes on trains operated with electro-pneumatic brakes is no more difficult than braking an automobile and requires very little instruction on the part of the road foreman. The advantage of electro-pneumatic braking on mountain grades is that the air brake system remains fully charged, so that in case of an emergency the full braking power is always available. The use of retainers is unnecessary and the train speed can be controlled more uniformly than it is possible with automatic brake; due to the ability of applying and releasing in uniform cycles, the wheels and shoes remaining comparatively cool, thus reducing brake shoe wear and saving of wheels from damage due to over heating.

One fact is evident, that is the positive application of sand in sufficient quantities and so delivered that its full benefit is realized for tractive purposes, will provide a coefficient adhesion under all conditions at least as high as that obtainable with a clean dry rail. If a rail adhesion efficiency was available at all times a brake design of much higher capacity could be developed to predict stops with greater confidence and accuracy. The subject of adequate sanding of the rail to insure uniform wheel rail adhesion is being constantly studied, but not as yet fully solved. Some railroads have gone so far as to install additional sanding devices in two or more locations of one train, being arranged so that at a predetermined cylinder pressure automatic sanding will occur. On others sanding is initiated by wheel control operation. The additional sanding stations were judged necessary, since when wheels pass over sand at high speed the sand which is not blown from the rail or carried by the wheels at the brake shoes and lost, is ground so fine it has lost its efficiency by being repeatedly crushed.

However, even if a sanding device could be designed to efficiently sand the rail at 90 to 100 m.p.h. the problem of carrying a sufficient supply of loose sand on each truck for a usual trip of the present streamline trains is a major one.

It therefore appears definite to us that some other method of conditioning the rail must be devised for satisfactory results at the present high speed.

Electro-Pneumatic Sanding Equipment

The effectiveness of good clean silica sand to raise the coefficient of adhesion between the rail and wheel is unquestioned, but reliability of sand delivery introduces major problems.

The sanding equipment is designed to solve these problems in a practical manner. It is flexible and can be operated either pneumatically or electro-pneumatically. The pneumatic operation of the equipment is interlocked with the brake equipment so that its operation is initiated by an emergency application of the car control valve and continues over a predetermined time before being terminated automatically, thereby eliminating a useless waste of air and sand. The electro-pneumatic operation is controlled through electric circuits which are used at the discretion of the engineman to initiate or terminate a response simultaneously at all sander installations through the train. If not terminated by the engineman, an electro-pneumatic sanding operation will cease by action of a timing sanding valve in the cab after a predetermined time interval. The train sanding circuit is interlocked with a locomotive sanding circuit in such a manner that either the locomotive sanders alone may be used for locomotive traction when accelerating, or all train sanding stations may be simultaneously set into operation when desired.

Sand is dispersed positively and reliably to the point of contact between the wheel and rail by a new type of sand trap which includes a device for preventing high pressure air for cleanout purposes from blowing back into the sand box. The sand is conveyed from the sand trap to the point of application through a sanding hose and distensible rubber nozzle from which it is delivered. The sand trap is so designed that a minimum of compressed air is used to deliver the sand to the rail, atmospheric air being used in large quantities for agitating the sand within the trap.

The sand trap has two distinct functions. First, at the beginning of every sanding operation a short, but heavy, cleanout blast of air is directed through the sanding hose and nozzle to insure an unrestricted flow of air and sand. This cleanout blast of air may develop any pressure in the delivery line needed to open the sanding nozzle if it should be frozen over on the outside during winter weather. Second, sanding follows immediately after the cleanout blast. Another cleanout blast of air follows automatically at the termination of the sanding function.

The cleanout and sanding cycles of a group of traps at one station are controlled automatically by a sanding relay valve, which comprises a relay portion for providing the sequence of functions, a magnet portion for responding to the electro-pneumatic control, and an application portion for automatically responding to a local emergency brake application. The air supply is provided by a separate reservoir, which is charged through a valve which prevents interference with brake action.

The railroads are very much concerned with three principal factors affecting wheel service, shelling, thermal cracks and tread wear. Shelled wheel treads cause rough riding, and vibrations from this increase maintenance costs. To remove wheels for turning involves expenditure in tread metal and the cost of their removal and replacement. Thermal cracks require removal of tread metal or possibly the scrapping of the wheels when cracks are discovered. It is feared greatly as a possible source of broken wheels and possible derailment. Tread wear affects contour, riding qualities and as wear progresses the removal of wheels for reconditioning.

The report was signed by H. I. Tramblie, air-brake supervisor, C. B. & Q., and John Battise, general air-brake instructor, C. & N. W.

Discussion

J. Fahey (N. C. & St. L.) referred to the use of two conventional cars in the lightweight streamline train which operates over the N. C. & St. L., stating that with these cars in the train a higher-brake pipe reduction is required than when the streamline equipment is operating alone. He inquired if, when brakes reapply after brake-cylinder pressure has been reduced by the speed-control devices, the reapplication increases the cylinder pressure on other cars. Mr. Tramblie called attention to the relatively large tonnage which had been added to the train with the two conventional cars and said that these cars, having a lower braking ratio, required heavier brakepipe reductions to effect the same control.

J. Kane (N. Y. C.) inquired whether there is any difference in the functioning of the Decelostat and the wheel controller and asked whether the wheels actually slid when under the control of these devices.

In answer to this question Mr. Tramblie said that with either type of wheel control the wheel does not stop turning, sometimes slowing down not more than the equivalent of 10 miles an hour. When wheels slide, he said, retardation is only 20 per cent as much as when rotating; with the slip controlled the retardation never got below 60 per cent through the complete cycle of the operation of the device.

J. P. Stewart (Mo. Pac.), referring to the experience of the Missouri Pacific with the HSC brakes on streamline trains, said

that there had been very little maintenance cost with these brakes. Once men use the electro-pneumatic brake, he said, they do not like to go back to the automatic brake. He referred to a run on which two lightweight cars equipped with HSC brakes move in one direction regularly in a train of nine conventional cars and said that the performance was entirely satisfactory, with no slack action or rough handling. Up to September 10, he said, the high-speed trains on the Missouri Pacific had made 3,251,584 car-miles and 582,464 locomotive-miles, with five pairs of slid-flat wheels on the cars and two pairs on the locomotive, both on idler wheels. He advocated buying new passenger-car brakes with D-22 control valves with the idea that sooner or later they will be converted to the full HSC schedule.

Terminal Tests and Road Handling of Long Freight Trains With Mixed K and AB Equipments

A fundamental requirement for every air brake engineering problem is that new and improved apparatus must not be introduced unless it will operate in harmony with and contribute towards the improved operation of the existing brake apparatus. The AB brake equipment was designed on this basis so that when it is mixed in trains of cars having the type K brake equipment, it not only functions better but it also improves the functioning of the train brake as a whole.

The benefits which are realized from the installation and use of the AB freight car brake equipment can be classified under two headings. The first class of benefits relates to the improved operation, which is especially important in the safe and smooth control of long trains, that is, trains made up of more than 100 cars. The second is lower maintenance costs which result from constructional features that make a longer cleaning period feasible and better inspection and repairs possible.

The lower maintenance costs have been well demonstrated by the repair shop experience which has now become quite general. As the percentage of AB brake increases, the shop facilities and methods will be perfected so that the minimum costs will be assured, but for the purposes of this discussion we are primarily concerned with operation characteristics. It is the improved functions of the AB brake which make possible the satisfactory control of long trains now in service, even when they have a considerable percentage mixture of the old style K brakes. A comparison of the K and AB brakes shows that the outstanding differences are in the application and release, which are the fundamental brake functions.

The integrity of the AB application is very much improved over that of the K because it has a superior form of quick service, which is a three stage limited type as compared with the continuous type used in the K. The AB quick service is initiated by a movement of the piston and graduating valve only, whereas the K quick service must wait on enough pressure differential to move the main slide valve. When the AB graduating valve moves it causes a rapid drop of brake pipe pressure into a fixed volume, which initiates and propagates quick service through the train and this is followed by a further drop at a slower rate by venting to atmosphere until the slide valve moves to produce the application of the individual brake. In this manner the effect of slide valve resistance on the quick service action is eliminated and the speed of propagating a service application throughout a long train is thereby greatly increased.

The initial quick drop starts a pressure wave that travels along the pipe rapidly to start the next valve, where the action is repeated so that when quick service is initiated it will travel with full speed and make every valve apply in the longest train. This action is not duplicated by the continuous type of quick service in the K because high slide valve resistance can delay its initiation at any car for varying time periods and, consequently, it may sometime fail to propagate a light application throughout a train of 100 or more cars. The more dependable and vigorous quick service action of the AB is such that any mixture of those valves in a K train will assist in making the K valves more certain to apply and thus insure a better train brake control.

The speed and reliability of the release function of the AB brake is also greatly improved in two ways. The first is the quick recharge feature provided by the added emergency reservoir and the second is the release insuring feature which eliminates the slide valve friction as a factor in delaying or preventing an intended release.

The emergency reservoir remains fully charged during a service application. When a release is started and the first slide valve moves to release position, a port opens which connects the emergency reservoir to the auxiliary reservoir. This port is controlled by the graduating valve and it functions to recharge the auxiliary reservoir, without drawing any air pressure from the brake pipe, until after the two reservoirs are nearly equalized. This feature makes it possible to raise the brake pipe pressure to the releasing point throughout a long train within a shorter time than is possible with K valves which draw air from the brake pipe as soon as the release starts.

The AB release insuring feature is built in so that with the valve in service lap position and the brake pipe pressure raised 1½ lb. above the auxiliary reservoir pressure, the insuring valve will open and vent auxiliary reservoir pressure until the rapidly increasing pressure differential forces the valve to its release position. This vent is cut off when the slide valve moves and if the slide valve resistance happens to be equivalent to 1½ lb. or less, it will not occur. Thus this device only function to vent when necessary and then only to the exact degree required to release a valve having high slide valve friction. It thereby eliminates any chance of a release failure due to a combination of slow brake pipe pressure rise and high valve friction.

The improved AB application and release features have been briefly described here because they have an important bearing on the successful handling of long freight trains. While the full advantage of AB brakes can only be obtained with 100 per cent AB equipment, as AB brakes are mixed with K brakes, the improved functions become more effective and it is feasible to extend the train length and thus take increased advantage of the high capacity of the modern locomotive.

Terminal Tests

It is good practice to begin terminal tests when a train enters a terminal. The engineman should apply the brakes by making a full service application before the engine is detached from the train. The car inspectors can then begin inspection to see that each brake is applied and check for long piston travel or any other visible defects.

At this time cars with defects can be marked so that the necessary repairs or adjustments can be made at a time and place designated by the yard master and thus avoid any delay in the switching of the train. Close cooperation between the inspectors and yard master for handling these repairs will work out to good advantage. A yard compressor plant for charging trains in the terminal will be a very valuable aid for reducing the brake system leakage as well as for making the required terminal tests.

Charging

1. Water condensation and dirt must be blown from the line from which air is taken before connecting the yard line or locomotive to the train.

2. The train must be charged to the standard pressure. The retaining valves and retaining valve pipes must be inspected and known to be in suitable condition for service. The position of angle cocks, cut out cocks and hose connections must be checked. The train brake system must be examined for leaks and necessary repairs made to reduce leakage to a minimum.

3. The terminal test can be made from a yard plant provided the equivalent of an automatic brake valve is available and connected to same point in train that engine is to be attached, otherwise this test must be made after the road locomotive is attached. When test is made from a yard plant, a road test must be made before the train is permitted to depart.

4. In preparing to make terminal or other tests it must be re-

membered that an AB equipped car requires at least seven minutes to charge from zero to 70 lb. Frequently charging passages are restricted and a greater length of time is required to charge such cars. If an attempt is made to apply such brakes without allowing time for them to charge sufficiently, they will fail to apply, and may be undercharged to the extent of indicating false brake pipe leakage. In order to overcome this condition 12 min. should be allowed for charging and on some trains it may be necessary to extend the charging time to 15 min.

Test

1. When the train is known to be charged within 5 lb. of full brake pipe pressure, as indicated by locomotive gauge, a 15 lb. service reduction must be made upon proper signal or request and the brake valve handle then placed in lap position. The brake pipe gauge on the locomotive must then be observed for one minute to determine the brake pipe leakage in terms of pounds drop in one minute. It is preferable that this leakage should be less than 5 lb. but it must not exceed 7 lb.
2. Following the leakage test the brake pipe service reduction must be increased to 20 lb. The train must then be examined to determine that the brakes are applied in service application on each car, that the piston travel is not less than 7 or more than 9 in. and that there is no binding or fouling in the brake riggings.
3. Excessive brake pipe leakage must be reduced to a point where it does not exceed the maximum value permitted and all cars found with wrong piston travel must be adjusted to near the nominal value of 8 in.
4. When this examination is completed and upon the receipt of a proper signal, the brakes must be released by using a brake valve manipulation that will avoid overcharging. Each brake must be examined to see that it releases.
5. Other defects found during these tests which can not be repaired promptly must be reported to the inspector foreman or the conductor for appropriate action. The inspector or trainman who made the examination must personally advise the engineman and conductor, giving the number of cars in the train and the number of cars which have inoperative brakes.
6. At points where motive power, engine crew or train crew are changed terminal test must be made.

Road Test

1. On a freight train, before an engine is detached or an angle cock closed on an engine or a car, the brake must be fully applied. After recoupling and opening the angle cock and before proceeding, it must be known that the brake pipe pressure is being restored as indicated by the caboose gauge and that the rear brake released. In the absence of a caboose gauge the inspector or trainmen will note that the rear brakes of train apply and then signal for a release, noting that rear brakes release.
2. When one or more cars are added to a train at any point subsequent to a terminal test the cars added, when in the position where they are to be hauled in the train, must be tested as prescribed in terminal test above. Before proceeding, it must be known that the brake pipe pressure is being restored as indicated by the caboose gauge and that the rear brakes are released.

Train Handling

The mixture of AB brakes with K brakes in freight trains raise the train length limit for safe and satisfactory handling, and this rise will be roughly proportional to the percentage of AB brakes introduced. The benefits derived from a given number of the new brakes will be greatest if they are uniformly distributed through the train.

The percentage of all freight cars that are equipped with AB brakes is increasing rapidly and on some railroads which have a large percentage of their home cars equipped, the average number of AB brakes in regular trains is well over 50 per cent. Several of these properties are taking advantage of the resultant better brake performance and are operating trains both loaded and empty in regular service, which are well over 100 cars in length, ranging upwards to as high as 150 cars.

In all cases where AB brakes predominate and the new valves are fairly well distributed, the dependable functioning of the train brake is not the problem it would be if all brakes were of the K type. However, the smooth handling of such trains does involve many problems which the engineman must be prepared to solve as they arise. This subject is exceedingly complicated because there are numerous governing factors which can vary widely and consequently the space and time here available will permit a citation of the more important aspects of long train operation.

The fundamental consideration for smooth train handling is the control of the relative slack movement between different portions of a train which can occur because of the slack or lost motion which always exists between the couplers and the draft rigging of the cars. The total slack is made up of free or unresisted movement caused by wear on the coupler pulling faces and in the draft rigging, plus the travel of the draft gears at each pair of couplers. The total slack is sometimes measured by noting the change in the train length between having the train compressed with the slack all in and having the train stretched with the slack all out, but such a measurement is only relative because a greater slack change can result under some service conditions due to forces which often exceed the maximum drawbar effort.

The freight car draft gear commonly has a working travel of 2½ in. in each direction. That is, from its neutral position the coupler shank can be pushed inward 2½ in. or be pulled outward 2½ in. against the resistance of the gear. The total slack movement that comes from the draft gear is 5 in. per gear or 10 in. per car. In compression or extension the gears are being closed against the resistance of the gear friction. When the slack reverses, the gears are being expanded by their release springs and, since the force exerted by these springs as modified by the friction elements comes into play just when the slack movement has started to reverse, it can often combine with other forces acting on the train to accelerate the rate of slack change.

The free slack motion is a much smaller portion. The amount will depend on the normal knuckle clearance and the degree of wear in couplers and draft rigging parts. Test records indicate that the average free slack for all freight cars is in the neighborhood of one inch per car which means that the total slack is around 11 inches per car. On this basis the total slack movement possible in trains will be about 91 ft. for 100 cars, 110 ft. for 120 cars, 137 ft. for 150 cars, etc.

If long trains could be tightly coupled and have rigid draft rigging of sufficient strength, all slack movement would be eliminated. The locomotive would then need enough power to start all cars in the train at the same instant. Any force such as power, braking, track grade, track friction, train friction, etc., which might be applied to any portion of the train would be instantly transmitted to every car in the train. Under such circumstances it would not be possible to have damaging shocks with any method of train handling. This is purely an imaginary condition which is not practicable, but even if it could be accomplished it would be unsuited to long train operation.

When a car begins to move there is a sharp decrease in the journal friction so that the draw bar pull required to keep it moving is much less than that which was required to start it moving. It is this journal friction characteristic which makes train slack movement very essential for starting trains when the tonnage is closely matched to the power of the locomotives. From this standpoint the existence of train slack is so beneficial as to make it a necessity, but from the standpoint of train handling it offers some serious problems in avoiding objectionable shocks.

Any train en route is continually subject to varying forces which act to either accelerate or retard it. The locomotive pull on a down grade will produce acceleration, whereas the frictional resistance, up grade and brake action are some of the forces that will produce retardation. These forces are seldom effective on the whole train but usually affect it in different parts and to a varying degree so that the different parts of the train will tend to assume different speeds. Whenever such a difference can act to run the slack from all in to all out or vice versa, some portion of the train will be subject to a shock at the instant the slack movement ends and all parts of the train are forced to assume the same speed.

The degree of shock will depend on how fast the slack is moved, the weight of the train portions and the yielding resistance of the draft rigging through which the forces must be transmitted when the slack run ends. The serious and sometimes damaging shocks occur when force differences are allowed to develop which can run the slack in or out rapidly. If the engineman uses due care in manipulating the throttle and the brake control in combination with a knowledge of the slack status and the track conditions, it is often possible to avoid a slack reversal and nearly

always possible to avoid a run of the slack which will be fast enough to produce any rough action.

The locomotive throttle is an important factor in slack control because it can be manipulated so as to prevent or at least slow down a run of the train slack under many conditions. It is usually expedient to open or close the throttle gradually so that the train slack can adjust itself slowly as the engine effort is changing.

The serial action of the brake is perhaps the most important consideration in the control of train slack movement. When a train brake is either applied or released its action is always propagated from the point where it is started. In other words, after the brake action begins on the first vehicle there is a time interval to the functioning of each succeeding brake.

For application the front brakes of the train can develop heavy retardation before any braking is effective on the rear cars. If the train is running forward with the slack stretched, this serial development of the retardation can generate heavy forces which will tend to cause a slack closure. Likewise, if the train is running forward with the slack compressed and the brake is released, the serial action can generate heavy forces that will tend to run the slack out. The propagation time for both the application and release functions is roughly less than one-half for a solid AB train compared to a train made up of all type K valves. This shorter time, combined with the controlled quick service action of the AB brake, greatly reduces the tendency of the brake serial action to run the slack so that for any given set of conditions it will be easier to control the movement of the slack in proportion to the admixture of AB brakes. In every case where a brake manipulation is required the engineman must keep these tendencies in mind and govern the control of power and braking so that a rapid change on the slack can not occur.

The many combinations of conditions which can affect the rate of train slack change are so numerous that it is not possible to cover the subject fully in this discussion. However, the following comments relate to certain circumstances that are typical conditions for long train service and will point out some of the more important methods of manipulation which are usually employed to prevent or retard the movement of the slack in these trains.

Assuming that a train of all loaded cars is moving forward on a straight level track with the locomotive working hard to hold the train stretched and the need for a stop is indicated, the engineman must move the throttle slowly to the closed drifting position and allow the train to drift. The internal resistance of the engine combined with the draft gear recoil action on the cars will start the slack to move inward slowly. After waiting a suitable time for the slack to adjust itself and thereby reduce the forces which were stored in the draft gear, a light service application reduction of not over 6 pounds can be made.

If the train speed is low, 15 m.p.h. or less, and particularly of the brake pipe leakage is considerable and K brakes are numerous in the front portion of the train, it may be advisable to use steam when the brake application is started because these factors tend to increase the velocity of slack movement and, as the speed becomes lower, the effectiveness of a given brake application will increase rapidly with a corresponding tendency to run the slack too rapidly. If the speed is high enough and conditions require, a second application reduction of about 8 lb. can be made to complete the stop after sufficient time has elapsed following the initial 6 pound reduction to allow a complete adjustment of the slack. This time may be about 20 seconds after the brake valve closes for the first reduction when on level grades, but may be much longer when the rear portion of the train is on a hump or curves.

Where the conditions are the same as stated above, but there is not sufficient time and distance to make the stop in the manner described, a heavier application, say a 10-lb. reduction, can be started promptly with the locomotive throttle open and the locomotive brake held released. In this manner the tendency of the heavier brake application to run the slack in rapidly will be modified by the pull of the locomotive. As the train slows down, the throttle must be closed gradually to suit the working of the engine and be in the closed position about 40 ft. from the final stop. At this time the locomotive brake must be applied sufficiently to avoid an excessive strain on the tender draw bar at the instant of final stop.

The manipulation described is only a rough outline of methods which can be used to control slack movement. The set of conditions assumed are subject to many modifications which may require corresponding changes in handling in order to avoid objectionable shocks. For example, if in the stop zone the forward part of the train is entering curved track or is encountering some up grade, these conditions will produce retardation force that will add to the brake serial action forces which act to drive the slack in. In some instances, these forces may be great enough to close the slack roughly without a brake application so that it is necessary to have the locomotive exert some pull until the slack closes to the point where it is safe to start the brake application.

Another factor which has an important bearing on the method of handling is the load distribution when trains are made up with a mixture of empty and loaded cars. A given degree of brake application will change the speed of a group of empty cars much faster than it will change the speed of a corresponding group of loaded cars. This ratio of difference in rate of speed change can be as much as 2 or 2½ to 1. Whenever the cars are distributed so that these uneven rates of retardation can cause a difference of 3 or 4 m.p.h. speed in separate parts of the train before the slack movement is completed, an internal collision or severe jerk must result as the point is reached where the slack is all in or all out. It is necessary for the engineman to know how the train is loaded and modify his manipulation of the throttle and the brake so that a serious speed difference can not develop within the train before the slack is adjusted.

The releasing of the brake when the train is in motion is often difficult to accomplish without a serious jerk shock because the train slack is often compressed during the preceding brake application. The release starts and runs serially from the head end and this will tend to run the slack outward. Under some conditions the retarded release feature of the K valves, combined with AB slow release, will be sufficient to allow the slack to move out gently. If loaded cars are grouped on the head end or the train is passing into down grade it may be necessary to hold the locomotive brake applied sufficiently to prevent a fast run out of the slack during the train brake release. When conditions will permit the train slack to be gently stretched before the brake release is started, there will be little danger of a rough run out.

Care must be exercised when stopping trains that are backing. The pushing of the locomotive will usually have the slack compressed so that if the throttle is closed and the brake is applied, a fast outward slack movement towards the rear is certain. The usual practice for such stops is to make a light brake application with the throttle open far enough to keep the slack pushed in until the brake application can become effective throughout the train.

The practice of attempting to make spot stops of long trains for taking water and coal often produces rough handling. The reason is that this procedure usually involves the use of the brakes at very low speeds where even a light application of the locomotive or train brake is apt to be highly effective and produce correspondingly heavy slack action. It is a better practice to stop a long train smoothly at a point where some latitude is available and then cut the locomotive off for fuel and water.

The successful handling of long freight trains involves a slow movement of the train slack both in starting and stopping. The slack can not be changed both quickly and smoothly at the same time. The time element is very important in all brake operations and this importance increases as the train length increases. In the unusual cases the engineman must use good judgment regardless of any general instructions.

In conclusion we wish to point out that the only hard and fast rule for the smooth handling of long freight trains can be expressed in three words, which are, "Change slack slowly." It is not always easy to follow this rule because the correct method of handling must be modified according to track grade, track curvature, train loading, train length, type of cars, type of locomotive, effectiveness of brakes and other conditions of less importance. The engineman must study how these controlling conditions vary for different trains at each stop location and then do the needful. Experience has shown that with careful operation trains of mixed AB and K brakes as long as 150 cars can be successfully handled in daily service.

The report was signed by F. T. McClure, assistant supervisor of air brakes, A. T. & S. F.

Discussion

J. Kane (N. Y. C.) spoke in favor of making slow-downs of freight-trains with an open throttle and with the locomotive brakes released. In many instances, he said, the brakes on long trains handled in this way can be released without stopping the

train after a slow-down. This saves fuel, he said, as does also the reduction in the number of break-in-twos effected by this.

J. P. Stewart (Mo. Pac.) objected to the statement that there is 11 in. of slack in each car; without carefully qualifying it, the statement is misleading when all but 1½ or 2 in. of this possible total movement is cushioned and not shock producing.

J. Fahey (N. C. & St. L.) said that since the practice of braking against the open throttle had been in use on the N. C. & St. L. there had been no pulled drawbars. He said that freight trains are operated at 60 miles an hour and can be handled almost as smoothly as passenger trains by this practice.

O. E. Ward (C. B. & Q.), commenting on the amount of slack in freight trains, suggested that the Railway Fuel and Traveling Engineers' Association was the appropriate body to undertake an investigation to see if it is not possible to get along with less slack. He said that the handling of freight trains is no longer a tonnage proposition, but a matter of time, and suggested that the air-brake companies could make a real contribution to improvement in this respect if the AB brake could be made to charge a little faster.

W. H. Davies (Wabash, retired), called attention to the effect of differences in the braking ratios on the cars in a long train which may cause slack to run in and out at several points in the train. This can be avoided by the open throttle which assists in the adjustment of the slack gently. As to the effect of this practice on fuel consumption, he said that the division where this practice was started received the banner for the best fuel performance.

H. W. Sefton (C. C. C. & St. L.), cited as one of the reasons for the greatly improved train-handling conditions now as compared with 35 or 40 years ago the marked reductions in brake-pipe leakage. In braking trains with the open throttle he pointed out that the throttle need not remain fully open until the stop; it can be eased off after the slack has adjusted itself.

In his closure Mr. McClure agreed with Mr. Sefton as to the easing off on the throttle. In commenting on the time required for charging the AB brake he said that some of the delays charged to this cause could be eliminated. For instance, when cutting new cars into a train en route they could be recharging while the locomotive is moving them into the train.

Elimination of Oil and Water in Air Brake Systems

The assignment of the above subject for this paper clearly infers that the presence of oil or water in excessive amounts in air brake systems is undesirable, and the Committee is willing to go a step further and say that both are detrimental to flexible brake operation. The effective control of oil and water in air brake practice is often difficult to accomplish because the factors responsible are numerous and frequently very complicated.

When an excessive amount of oil is passed into the train brake system it usually originates in the lubrication apparatus of the compressors. The heat resisting lubricating oil used for the compressor air cylinders will not dissolve or evaporate into the air as water does, yet it will often travel from the compressor through the main reservoirs, brake valves, and appear in the train pipe in sufficient quantity to flood the pneumatic devices. This is a bad condition which interferes with proper lubrication, introduces dirt, damages rubber materials, and is frequently responsible for erratic brake action.

The primary cause for excessive oil is the lack of proper lubrication control. It is essential that the oil feed for the lubrication of compressor air cylinders be carefully regulated to provide the right amount of oil at a rate that will correspond to the rate of compressor labor. Too little lubrication is objectionable because it reduces the compressor life but over lubrication leads to train brake trouble which are just as serious.

Hand controlled lubricators such as the hydrostatic type can be used but they must be frequently checked and adjusted. The preferred type of air compressor lubricator is a device or cup which will automatically feed a measured quantity of oil that will be proportional to the compressor speed.

Compressor condition is a secondary factor in the passing of oil into the brake system because the oil must pass through the main reservoir in the form of an atomized vapor. When the air cylinder piston rings are a poor fit on the cylinder walls and the piston grooves, the numerous small leaks will atomize the oil so that it can travel a considerable distance through the piping before it resumes a liquid form. Otherwise, an excessive amount of oil fed will only pass through the air cylinders and be trapped in the main reservoirs. For this reason it is important that care and good workmanship be used to insure an accurate ring fit on true cylinder walls, correct piston clearance and good ring groove fit when compressors are overhauled in the shop.

The detrimental effect of free water in the air brake system makes itself manifest in two ways which are: first, by destroying the lubrication, and second, by freezing.

The passing of water through the pneumatic valve mechanisms not only washes away the lubricant on the rubbing surfaces, but it carries much dirt and grit along with it to come into contact with the wearing parts. This causes exceedingly rapid rates of wear at critical points which, in turn, result in costly premature failures in service along with much higher repair and maintenance costs. It also causes greater than normal friction between rubbing parts, which often means erratic operation that can interfere with smooth and reliable brake control.

The usual sources of this water are badly designed yard air plants and locomotive main reservoir air storage systems. In both cases it is a question of designing and arranging the apparatus between the compressor and the train so that all excess liquid moisture is removed from the air pressure before it is introduced into the train. The considerations which govern good design for adequate moisture control are rather complicated and in order to make them more easily understood, we will first discuss the general aspect of the laws which govern moisture as it is transmitted by air.

When air at any pressure is in the presence of water, the water will evaporate or dissolve into the air. If the air is very dry the rate of this evaporation will be relatively fast, but as the air nears the point of saturation the rate of evaporation will become slower and it will cease at saturation because then the air will have absorbed all the water it can hold; that is, the air in question will have attained a relative humidity of 100 per cent.

Since absolutely dry air has a relative humidity of 0 per cent, any value for relative humidity between 0 and 100 per cent is merely a measure of the amount of water dissolved in the air compared to the amount that air will hold when it is fully saturated.

The amount of water, measured by its weight, or volume, necessary to saturate a given quantity of air is dependent on two physical conditions. These conditions are: first, the pressure acting on the air, and second, the temperature of the air.

When the pressure of a given quantity of air is increased by reducing its volume but without a change in temperature, the total amount of water it can absorb to become saturated to 100 per cent humidity is decreased. When the temperature of a given quantity of air is increased without a change in pressure, the amount of water it can absorb will be increased. It follows that these characteristics are reversible; that is, if the air pressure is lowered by increasing its volume, the maximum possible water content will be raised, and if the air temperature is lowered, the maximum possible water content will be lowered.

These characteristics are illustrated by the curves of Fig. 1. The data of the curves plotted on this figure relate to a quantity of air measured as 10,000 cu. ft. at atmospheric pressure. This is the amount of free air contained in a cube measuring 21.6 ft. on each side and its actual weight is about 764 lb. Fig. 1 shows how the number of quarts of water necessary to saturate this quantity of air, horizontal scale, decreases as the air pressure is raised from atmosphere to 140 lb. per sq. in. gage pressure, vertical scale. This figure also shows how the amount of water necessary to saturate the same quantity of air, horizontal scale, increases with the increase of the air temperature, vertical scale.

Inspection of these curves indicates that for an increase of both the pressure and the temperature these characteristics are of opposite effect; that is, for increasing pressure the saturated

water content decreases, and for increasing temperature the water content for saturation increases. It will also be obvious that the pressure effect is relatively very much less than the temperature effect within the ranges of pressures and temperatures chosen.

Assuming that a given quantity of air is saturated to 100 per cent humidity, it will be noted from the data of these curves that any decrease in the pressure or increase in the temperature will reduce the degree of humidity to something less than 100 per cent. The air in either case will thus be able to evaporate some additional water before it will again attain a 100 per cent humidity. On the other hand, if the pressure is increased or the temperature is decreased, the relative humidity cannot go beyond 100 per cent and so a cloud of condensed excess moisture forms in the air. If the change continues, rain will begin to fall.

The effect of pressure and temperature of the air on its degree of relative humidity is well illustrated by the curves drawn

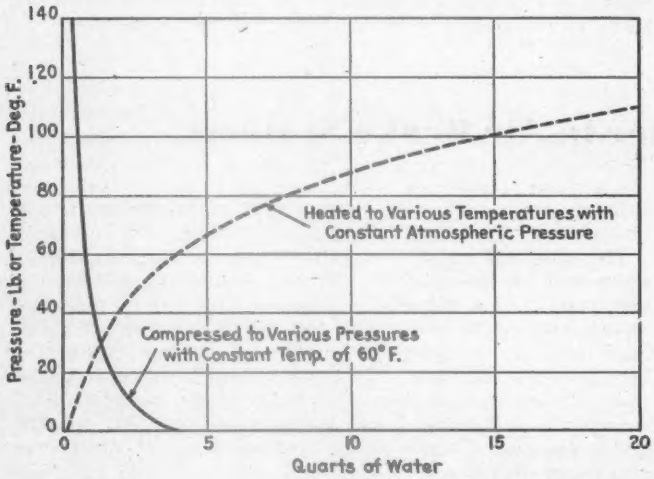


Fig. 1

on Fig. 2. This diagram shows how the relative humidity of saturated air changes as the pressure or temperature of the air changes. The horizontal scale is the pressure scale for the straight lines and the temperature scale for the curved lines.

Referring to Fig. 2, it will be noted as an example of what the straight line pressure curves show that if any given quantity of air is at 100 per cent humidity and compressed to a pressure of 140 lb. per sq. in., the expansion of this air from a pressure of 140 to 110 lb. per sq. in. will reduce the relative humidity of the air from 100 to 80 per cent. Likewise, referring to the curved line, if a quantity of air has a temperature of 50 deg. F. with 100 per cent humidity and the temperature is raised to 70 deg. F. the relative humidity will be reduced to 49 per cent. In other words, at this point in the temperature scale, heating the air 20 deg. F. doubles its ability to hold water. By the same token, cooling this air to a 20 deg. lower temperature will approximately halve its capacity to hold moisture.

Here again we see that within the temperatures and pressure ranges we have to deal with in operating air brake systems, the temperature effect is relatively much greater than the pressure effect and therefore it is the dominating factor in the designing of compressor plants so as to accomplish a satisfactory control of moisture. This is not only true for air brake systems but it also applies to all other kinds of pneumatic apparatus in which the presence of free unevaporated water cannot be tolerated.

The conditions which surround the operation of the air brake differ from those of other pneumatic apparatus in that all of its elements are operated out of doors and they are therefore subject to wide range of temperatures which extend from a maximum of 130 deg. F. downward to, and sometimes far below, the freezing point at 32 deg. F.

The entrance of moisture into the brake system takes place at the compressor suction in the form of water that has been evaporated into the free air drawn in for compression. The maximum amount of water is encountered when the atmospheric air around the suction strainer is at 100 per cent relative humidity.

We have previously stated that whenever air is in contact with water it will take up some water by evaporation until it is saturated, after which there will be no further absorption unless the air is then heated to a higher temperature or has its pressure reduced. Since the atmospheric air can generally contact damp objects such as the earth, plant life, rivers, lakes, etc., the humidity of the ambient atmosphere tends to be relatively high except in districts where it is exceptionally dry and arid. In case it is raining or when there is fog or mist, the relative humidity is 100 per cent. Since the latter condition occurs frequently or at least occasionally in nearly every locality it is necessary to design locomotive air compressor plants so that they will effect a proper control of the moisture under this maximum condition.

While the degree of atmospheric humidity which any given locomotive will encounter is dependent on the service location, the rate at which compressed air is used is also an important factor, because the total amount of water to be handled will depend on the amount of pump labor as well as on atmospheric humidity. It is therefore apparent that locomotives which regularly work in long freight train service in humid localities such as certain coast lines will be subject to the worst conditions for moisture.

Assuming that the atmospheric air entering the compressors at the strainers is at 100 per cent humidity, both the pressure and temperature of this air are increased rapidly as the work is done to bring it up to main reservoir pressure. The effect of these changes on the degree of relative humidity are opposed and tend to offset each other, but since the effect of the temperature rise is much the greatest the compressed air arrives at the compressor discharge at something less than 100 per cent humidity. The proof of this condition is the fact that free water is never found in or even near the compressor.

As this heated air at main reservoir pressure leaves the compressor discharge and flows along the discharge pipe, it cools rapidly so that a point is soon reached, usually a few feet from the compressor, where the falling temperature causes the relative humidity to rise to 100 per cent or the saturated value. This is sometimes called the dew point since it is at this point that a cloud of fog forms to start the deposit of all water that the compressed air is unable to hold evaporated.

From this point the air flows through the discharge pipe, the first main reservoir, the radiating pipe, the second main reservoir and thence by way of the main reservoir pipe to the control or distributing valve and brake feed valve. During this journey the cooling effect continues to reduce the temperature and thus more of the moisture is forced out of the air to be deposited along the path of its flow. When the air arrives in the main reservoir pipe ready for distribution to the air brake system, it will be at main reservoir pressure and 100 per cent humidity for its temperature, which should then be very close to the temperature of the surrounding atmosphere.

The use of the compressed air, either at the control or distributing valve or in the train brake pipe through the brake valve and feed valve, will be accompanied by a rapid expansion to a lower pressure. The expansion of the air will cause a sudden decrease in both the pressure and the temperature and since the temperature change has the greatest effect, a small quantity of moisture will be deposited locally at these expansion devices. However, as the air flows on at the now reduced pressure, its temperature will quickly rise again to near atmospheric temperature by absorbing heat from the piping so that its relative humidity will drop to a value considerably below 100 per cent.

For example, and referring again to Fig. 2, the data of the straight lines show that if the main reservoir pressure arrives at the brake valve at 100 per cent relative humidity and 140 lb. pressure and is then expanded into the brake pipe to 110 lb. pressure, the relative humidity will drop to about 80 per cent when the expanded air has recovered the same temperature it had before the expansion. Likewise, if the main reservoir pressure is 110 lb. and the brake pipe pressure is 70 lb., these data show that the relative humidity will drop to about 68 per cent.

The brake pipe pressure during release and recharge will average less than 110 lb. for passenger and 70 lb. for freight service and therefore the relative humidity of the air flowing through the brake pipe will be somewhat lower than 80 and 68 per cent, respectively. Air in this condition will be able to evaporate additional water and consequently if the compressor air storage system is designed so that the compressed air is cooled to near atmospheric temperature when it leaves the second main reservoir, the air brake system will always be dry.

The foregoing discussion seems to justify the conclusion that the proper control of moisture in pneumatic systems is a rather simple matter. However, experience with some locomotives designed in recent years has shown that the locomotive builders have a very serious problem in designing and locating the compressor plant elements so that they will meet the requirements as outlined. The ability of the pipe and reservoirs of any main reservoir layout to accomplish adequate cooling will depend on their size, and on how they are located so as to always have a free circulation of cooling atmosphere around them.

The economy of the modern steam locomotive has brought with it the use of many kinds of auxiliary apparatus, all of which must be suitably located. The air compressor plants also have a larger delivery capacity which means increased size for all the elements and thus in certain cases it becomes exceedingly difficult to secure an ideal or even a passably good location for every part. The streamlining of locomotives frequently operates to shield parts of the main reservoir system and this may prevent the proper circulation of air around its parts, with the result that the effectiveness of moisture elimination is greatly reduced.

The control of water in compressed air systems for air brakes is accomplished by designing the main reservoir piping and locating the capacity volumes so that the air will be sufficiently cooled during the maximum rate of flow to insure that the air supplied to the brake devices will have a degree of humidity something less than 100 per cent or saturation. The volume reservoirs can be used to collect moisture as it is deposited by the cooling air, but they must be located so as to have the greatest possible protection against the radiation of heat from the boiler or fire box. Otherwise, any water trapped in these reservoirs will be re-evaporated by the air and thus carried along perhaps to some vulnerable point in the air brake system.

The piping is an effective element for radiating the heat from compressed air because it provides a large cooling surface in proportion to the volume of air it contains. This function is dependent on having the pipe so located that atmospheric temperature air can circulate freely around it.

The reservoirs are relatively ineffective for radiating heat from the air, especially during the period of maximum air flow. This is because the heated air stream will not disperse, but will flow along the top of the reservoir so that the cooling effect is not much more than the equivalent to a pipe of the same length as the reservoir. In severe winter it is not uncommon to see icicles clinging along the bottom of a main reservoir when it is warm to the touch along the top.

It is not difficult to make frequent checks, under different weather conditions, on the ability of any locomotive main reservoir system to properly control the moisture in regular running service. It is only necessary to note whether water is seeping from the hose couplings of the train en route or at the end of a trip when the hose coupling is parted to uncouple the locomotive. A satisfactory main reservoir system will not cause the hose couplings on the tender and first cars to be wet if it is properly designed.

In some installations it may be necessary to place a drain cup in tender brake pipe. The function of the tender drain cup is to trap the water which is deposited at the point of expansion in the feed valve and hold it until the brake pipe air of relatively low humidity can re-absorb it. The quantity of the water involved is not sufficient to materially increase the relative humidity of the brake pipe air, but it is objectionable if this unevaporated water can enter the train brake pipe.

We have shown that the proper moisture control function of an air brake main reservoir system is dependent on a number of factors, such as variations in climatic conditions of humidity and temperature, the rate of air flow encountered, air pressure values used, etc. These factors are in turn dependent on the type of service for which the locomotive is intended and on the weather conditions which will prevail in its working territory.

Places to Look For Trouble

Reservoir Location—The reservoirs must be located where they will have free circulation of the atmospheric air around them and so that they will receive a minimum of heat radiated from the locomotive boiler and fire box. The purpose of these requirements is to secure a maximum cooling of the air stored in the reservoirs and to avoid any re-evaporation of water deposited in them.

Compressor Discharge Pipe—The pipe which connects the compressor discharge to the first main reservoir must also be located so as to have this maximum circulation of atmospheric air and a minimum exposure to heat radiated from the hot locomotive parts. This pipe must be installed with as many lineal feet of lengths as can be used without dropping the temperature of the compressed air at the first main reservoir inlet below 32 deg. in freezing weather. If this pipe is made too long, there may be trouble from freezing, but experience indicates that in most installations the discharge pipe can be as long as 45 ft. The moisture control function of this pipe is to cool the compressor air to as near atmospheric temperature as practicable without freezing near its delivery end under the most unfavorable conditions of compressor labor, high atmospheric humidity and low atmospheric temperature. It must be located so that all moisture deposited in it can drain toward the first main reservoir.

Radiating Pipe Between Reservoirs—The pipe connecting the first and second main reservoirs must also be designed and located so that it will be well ventilated and protected against heat radiated from the boiler and fire box. The function of this pipe is to reduce the temperature of the compressed air to as near atmospheric temperature as possible. When the atmospheric temperature is above freezing a small amount of deposited water will be delivered from this pipe to the second main reservoir but if the temperature of the air surrounding this pipe is below freezing, this water must be stored in this pipe as frost and it will remain there until the atmosphere temperature rises above freezing or the locomotive is housed in a place warm enough to melt the frost. For this reason this intermediate pipe must not be small in diameter and it may be much longer than the discharge pipe if greater length will aid in placing it where it can be most effective as a heat radiator. This pipe must be installed so that any free water precipitated in it can drain towards a reservoir.

Compressor Suction Strainer—The location of the compressor inlet strainers must be chosen in a place where they can receive clean, cool air and where they will not be exposed to the steam vapor of leaks which can occur around the cylinders and certain steam operated auxiliary devices. Any steam vapor entering the

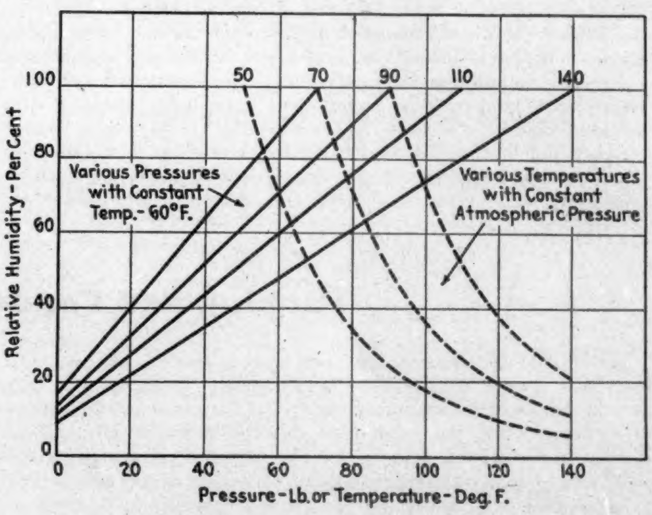


Fig. 2

strainer is equivalent to raising the relative humidity of the atmospheric air and the margin for safe moisture control will be correspondingly reduced.

Main Reservoir Supply Pipes—The location of the supply pipes to the brake valve and the control or distributing valve is not of great importance from the standpoint of moisture control. If the location of this pipe is such as to reheat the air en route to the brake valve, this may be of some benefit by reducing the amount of water deposited at the feed valve and the same is true for the air expansions that take place in the control or distributing valve. If these pipes are located where they are exposed to low atmospheric temperatures and they freeze, it is evidence that the other elements of the main reservoir system are not properly performing their cooling functions.

General Considerations

Occasionally, extra large or special purpose locomotives may be encountered on which the best feasible location of the reservoirs and radiating pipes will not give satisfactory control of moisture. In these cases, it will be compulsory to find a space somewhere on the locomotive such as between the frames or on the front end where additional radiating pipe can be installed in the line leading from the second main reservoir to the brake apparatus. This pipe can be of any required length, but it must be arranged so that the moisture deposited at any point in it can drain toward a trap reservoir. The trap reservoir must be large enough to hold all the water that can accumulate between drainings so that it will not be possible for any of this water to pass into the brake system.

In recent years very good moisture control has been accomplished for some large steam locomotives by installing an aftercooler in the main reservoir supply pipe; that is, in the pipe between the last main reservoir and the brake equipment devices. The aftercooler is made up with about 35 ft. of finned copper tubing, arranged as eight lengths in parallel between suitable headers. This device is installed on the frame just ahead of and shielded from the smoke box and it is equipped with an automatic drain valve that can eject any deposited water during each cycle of the governor operation. Some of these locomotives work in mountainous territory where they often pass from mild damp weather to extreme cold. There has been no report of freezing troubles nor indication that any moisture has passed into the train brake systems.

The Frisco Lines has been interested in the subject of aftercoolers or fin radiators for some years, making a trial installation on a Mountain type locomotive in 1936. As a result of this trial installation, to date 26 locomotives of this type have been equipped, with eight more on schedule. The cooler on these locomotives is in the discharge pipe between the compressors and the first main reservoir, and is mounted under the smoke box where it has a free circulation of air around it.

There are three main reservoirs on these locomotives (two on left side, one on right side) located under running boards where they have a free circulation of air around them. This installation was carefully followed to get an accurate check on the amount of water deposited in the reservoir and other appliances. There was no indication of water beyond the second main reservoir. In addition to the Mountain type locomotive, six semi-streamlined Hudson type locomotives have been equipped with the aftercoolers. On these locomotives the aftercooler is located between the first and second main reservoirs and is mounted on the front end under the streamlining cover in which an opening is cut out and covered with front end netting to provide for air circulation. Frequent checks under a wide range of weather conditions have shown the moisture control is satisfactory on these locomotives.

The fundamental requirement for the elimination of water in air brake systems is the cooling of the compressed air to a point where its temperature is within a few degrees of the temperature of the surrounding atmosphere. On many modern locomotives it is difficult to accomplish this unless some form of high efficiency heat radiation is used. The finned copper tube radiator described above has not only given excellent results in all its applications on the Frisco Lines, but it has been equally successful on other railroads.

In conclusion, the committee called attention to the need for keeping dust and dirt out of the compressor air cylinders. The significance of what will be accomplished by providing clean air for the compressor suction is well illustrated by the experience on the Frisco Lines which has now made the Type G suction filter standard equipment. Before this action was taken compressors used in the "dust bowl" territory required laundering once a month and once every three months in other districts. Since the filters were applied all laundering has been stopped and the shop records indicate that for two compressor installations the service life between compressor overhauls is at least four years. The important savings from the annoyance of failures and high maintenance costs will be obvious.

The report was signed by Frank Ellis, general air-brake instructor, St. L.-S. F.

Discussion

S. M. Roth (Western Maryland) told of a series of tests conducted by the Western Maryland on one of its recently built single-expansion articulated locomotives which substantiated the conclusion in the report as to the elimination of water effected by the use of the aftercooler.

After the new articulated locomotives were delivered, he said, trouble was experienced with water during the winter of 1940-41. An aftercooler was installed on one of the locomotives for test. The aftercooler is mounted on the front of the locomotive and part of it is connected between the air compressors and the main reservoir. The air discharge from the main reservoir passes through a 2-in. coil, thence to a sump and through the second portion of the aftercooler. Another sump is placed between this portion of the aftercooler and the second main reservoir. The tests, he said, were only completed on September 22 and a full report of the results are not yet available. He said, however, that the temperature of the air after it had passed through the aftercooler was only two degrees above the atmosphere. A large amount of water was discharged after the air had passed the aftercooler, and the air in the brake pipe was dry.

Turbine and Condensing Locomotives

During the last few months, and more than ever before, there has been special consideration and interest in connection with certain details of locomotive design. Two of these are the matter of so constructing the locomotive that the entire weight will be carried on the driving wheels; and the matter of using high-tensile light-weight material and refinement of design which will permit a locomotive of considerable horsepower capacity to be built in one unit.

In its report for 1939 and again in 1940, this committee proposed the use of gas or combustion turbines as the prime mover for locomotives. As stated in these reports, the Allis-Chalmers Manufacturing Company of Milwaukee, Wisconsin, had their engineers make a very thorough study and research in connection with using combustion turbines for furnishing power on locomotives. The consensus of opinion of the engineers of this company is that:

"With regard to the development of the gas turbine for application to heavy traction, nothing has occurred to change our opinion that this type of power generating unit can be applied to such service. The studies made two years ago indicate that, when the gas turbine unit is designed for a maximum operating temperature of 1,000 deg. F., both the efficiencies and weight-power relations are feasible. At the same time, it was recognized that increasing the inlet temperature to the gas turbine would improve the efficiency and also reduce the weight of the equipment for a given power.

"Since the studies two years ago, attention has been given to the development of gas turbine equipment for higher temperatures. At the present time, such a gas turbine is in the development stage. The development program includes the construction and complete testing of this equipment at a higher temperature. It was, therefore, deemed advisable to delay the active development of gas turbines for locomotives until the higher temperature test results of this experimental unit are available. . . .

"The metallurgical phase of the problem has also been given considerable attention. Development work is under way on new materials that show promise of being substantially better than the older alloys used in steam turbine or gas turbine work up to the present time. An extensive research program on metals is being continued, with every prospect that the results will aid further in the direction of increasing the upper temperature limit."

This committee is greatly encouraged by the whole-hearted confidence of the Allis-Chalmers Manufacturing Company's engineers who are making so thorough a research in this important development. We are satisfied that, when high-tensile, lightweight alloyed metal is again available, that it will be possible and practical to design and construct a gas turbine powered locomotive of 6,000 hp. capacity in one unit, and in this unit, carry sufficient

fuel and water to supply the locomotive during a 500-mile run, providing a direct mechanical transmission is used.

[The report then presented general specifications for a 6,000-hp. gas-turbine locomotive in a single cab unit based on the drawings and description of the 5,000-hp. locomotive set forth in the 1939 report.—Editor]

The report was signed by L. P. Michael (chairman), chief mechanical engineer, C. & N. W.

Coal Equivalents of Locomotive Fuels and Power

Those who are familiar with the interpretation of locomotive fuel performance statistics generally recognize the comparisons of the performances of different railroads in the common terms of pounds of coal per unit of service—thousand gross ton miles, passenger train car miles, yard engine hours—have little significance beyond the indication that may be given that there are fundamental differences in the general conditions having to do with location, construction, facilities, equipment, character of traffic, and requirements of service, which affect the operations of the different roads.

Under present instructions the monthly consumption of each of the various kinds of fuel and power is reported to the Interstate Commerce Commission by each railroad "reduced to their equivalent in net tons of coal, using such ratios of equivalence in heating values as the experience of the respondent indicates are applicable to local conditions." These quantities, stated as net tons of coal, are combined in the statistical statements of performance for the various districts and regions and for the Class I railways as a whole, and inevitably there is some tendency toward the drawing of comparisons between the published performances of individual roads, even between those that use different kinds of fuel and power.

For many years fuel-department men on the railroads have been concerned over the wide variation in the "coal equivalent" values used by the different railroads and the subject has been considered in several reports by the Committee on Fuel Records and Statistics. In its report for 1940 this committee showed the following ranges of values in use on thirty of the largest Class I railways:

	Minimum	Maximum	Average
Coal—B.t.u. per lb.	10,295	14,000	12,500
Fuel oil—gallons per net ton of coal...	115	215	161
Diesel oil—gallons per net ton of coal..	15	215	45
Gasoline—gallons per net ton of coal...	15	223	97
Electric current—kw. hr. per net ton coal	350	2,000	1,084

These coal equivalents used by different roads were reported to be based upon various methods of determination such as "comparative service tests," "comparative service performance," "data based upon tests," "comparative heat content and thermal efficiency," "coal consumption per kw. hr. in company plant," "coal consumption per kw. hr. in public utility producing plant."

The report and the discussion of the report brought out the point, with which there was no disagreement, that "a consistent equivalent value would be one that would produce a fuel unit, in pounds of coal per 1,000 gross ton miles, of the same order of value as that produced on the same territory by coal-burning locomotives in the same kind of service," and therefore, that "the conversion factor should be such that a road using electricity, fuel oil, gasoline or Diesel fuel could at any time return to the use of coal without affecting the value of the fuel performance units" on the territory in question.

Our Executive Committee has assigned to the Committee on Fuel Records and Statistics this year, the task of proposing forms of procedure for the determination of coal equivalents for each of the several fuels and power commonly used and reported on O. S. forms, that would to a reasonable extent meet the statistical requirements of equivalence as stated above, for presentation to the various roads through appropriate channels with the suggestion that serious consideration be given to their adoption.

In approaching this assignment your committee desires to make it clear that the members entertain no thought that any one set of arbitrary formulae should be proposed as suitable for all roads or even for all conditions on any one road, and certainly it is not to be expected that the same equivalent values could be considered applicable to every road in the country. Each particular situation undoubtedly requires individual study and treatment with due consideration to the conditions by which it is governed. However, there is no reasonable justification for the extreme variation in values that the present reports show, and we believe that this range in values could be very greatly reduced, with consequent improvement in the reflection of the existing situations, if more careful consideration were given by many roads to the determination of the actual conditions which apply to the problem and to the proper procedure to be followed in establishing the coal equivalents.

The most truly representative and consistent values of coal equivalents are those developed by qualified personnel from actual observation and study of the fuel consumption and the service units produced by the fuels or power in question as compared with the coal consumption and the service units produced by coal burning locomotives in the same service. Where this procedure is not practicable and reliance must be placed upon theoretical treatment or calculation by formulae we favor the procedure that takes into account for each of the fuels being compared, the known factors that are favorable and those that are unfavorable through the medium of suitable constants carefully worked out and properly applied. These constants should take into account any differences in the amounts of the fuels consumed incident to the preparation of the locomotives for service as well as any differences in the efficiency with which the fuels are utilized by the locomotives in service on the road, since in every case all the fuel issued to the locomotives is a charge against the service they perform and enters into the calculation of the fuel performance units.

With these considerations in view we have set up in following sections suggested forms of calculation to determine the coal equivalent of each of the several kinds of fuel and power, and by way of illustration have tabulated the results of such calculations for a few selected values of the factors involved, which we consider to be fairly representative of actual practice in each case.

Coal Equivalent of Fuel Oil Burned in Locomotive Fireboxes

The factors involved in the proposed formula are:

Fuel	Factors	Values used in example,
Coal	(1) B.t.u. per net ton.	25,000,000 (12,500 B.t.u. per lb.)
Coal	(2) Per cent of the total coal disbursement used on road (total less consumption for terminal servicing of locomotives).	90
Coal	(3) Per cent of efficiency of the combustion of the coal.	65
Fuel oil	(1) B.t.u. per gallon.	135,000
Fuel oil	(2) Per cent of the total oil disbursement used on road (total less consumption for terminal servicing of locomotives.)	96
Fuel oil	(3) Per cent of efficiency of the combustion of the fuel oil.	76

Example: $25{,}000{,}000 \times .090 \times 0.65 \div 135{,}000 \times 0.96 \times 0.76 = 148$ gallons per net ton.

Factors 2 and 3 may be combined into a single factor for each fuel representing the efficiency of its utilization. Thus, $0.90 \times 0.65 = 0.585$, representing the efficiency of utilization of the heat content of the coal under the conditions assumed for the example. Likewise $0.96 \times 0.76 = 0.73$, representing the efficiency of utilization of the heat content of the fuel oil under the conditions assumed for the example. These two factors may also be combined into one, thus, $0.585 \div 0.73 = 0.80$, which may be considered the efficiency of the utilization of the coal relative to the utilization of the fuel oil. Such a factor may for convenience be referred to as the utilization factor of the coal relative to the oil.

The proposed formula will then take the following form: (a) B.t.u. per net ton of coal $\times$ (b) utilization factor of coal relative to oil $\div$ (c) B.t.u. per gallon of oil $=$ (d) fuel-oil coal equivalent, gallons per net ton.

With the thought that a range from 0.75 to 0.85 for this factor will embrace the limits of any ordinary service conditions experienced, we have prepared the following tabulation to illustrate

the probable limits of the values for fuel-oil coal equivalents in gallons per net ton, considering coals of from 13,500 to 11,500 B.t.u. per pound and oils of from 130,000 to 140,000 B.t.u. per gallon.

Fuel Oil-Coal Equivalent—Gallons Per Net Ton

Coal, B.t.u. per lb. and per ton	Fuel oil, B.t.u. per gallon	Gallons per net ton		
13,500 per lb. 27,000,000 per ton	130,000	177	166	156
	135,000	170	160	150
	140,000	164	154	144
12,500 per lb. 25,000,000 per ton	130,000	163	154	144
	135,000	157	148	139
	140,000	152	143	134
11,500 per lb. 23,000,000 per ton	130,000	150	141	133
	135,000	145	136	128
	140,000	140	131	123
Utilization factors of coal relative to fuel oil		0.85	0.80	0.75

Kilowatt Hours Equivalent to One Net Ton of Coal

The formula proposed by your committee follows the method of comparing the amount of work measured in kilowatt hours produced by a ton of coal consumed by steam locomotives, including the coal consumed in terminal servicing, with the amount of electric current measured in kilowatt hours that must be purchased or generated and metered to the transmission system for the production of the same amount of work by the electric locomotive.

The factors that must be known or determined for use in the computation are:

1. The average number of pounds of coal consumed by the steam locomotives per horsepower hour, and the equivalent per kilowatt hour, one kilowatt hour being equivalent to 1.34 hp. hr. Dividing 2,000 lb. by this number of pounds of coal per kilowatt hour gives the equivalent number of kilowatt hours of work produced by the steam locomotives per ton of coal consumed.

2. The average combined efficiency of the electric transmission system and the electric locomotives with allowance for standby consumption of the locomotives. The reciprocal of this value shows how much greater must be the gross amount of electric current procured than the net amount actually converted into work by the electric locomotives, which latter value we compare with the work output and corresponding coal consumption of the steam locomotives.

The proposed formula takes the form shown below: 2000 ÷ pounds of locomotive coal per kilowatt hour × 100 ÷ percentage of combined electrical efficiency = coal equivalent, kilowatt hours per net ton.

Example:—Factors—(1) 4.0 lb. of coal per hp. hr.
or 5.36 lb. of coal per kw. hr.
(2) 70 per cent combined electrical efficiency.

$2000 \div 5.36 \times 100 \div 70 = 533$ kw. hr. per net ton of coal.

With the thought that a range in factor (1) from 3 lb. to 8 lb. per hp. hr., and a range in factor (2) from 60 to 80 per cent combined electrical efficiency will embrace within their limits any ordinary service conditions, we have prepared the following tabulation to illustrate the application of the proposed formula and to indicate the probable proper limits of the values for coal equivalents in kilowatt hours per net ton.

Kw. Hr. Purchased Per Net Ton of Coal

Steam locomotive factors: Lb. coal per hp. hr. of work produced	Lb. coal per kw, hr. of work produced	Kw. hr. of work produced net ton of coal	Kw. hr. of electric current purchased or produced per net ton of coal				
3.0	4.025	497	825	765	710	662	621
4.0	5.360	373	621	574	533	497	467
5.0	6.700	299	498	460	426	398	373
6.0	8.050	249	415	384	356	332	312
7.0	9.380	213	353	328	305	284	266
8.0	10.720	187	311	288	268	249	234
Per cent of combined efficiency of electric			60	65	70	75	80
transmission and electric locos.—(reciprocals)			1.67	1.54	1.43	1.33	1.25

Gasoline—Coal Equivalent

The correct calculation of the equivalent value of coal consumed in steam locomotives as compared with gasoline consumed in locomotives or motor cars propelled by internal combustion engines in the same service, must be based upon knowledge of the combined thermal and mechanical efficiencies of the respective types of locomotives in the particular service and the proportions of the total coal disbursed to the steam locomotives and the total gasoline disbursed to the gasoline locomotives that is not utilized in doing the work because it is consumed in terminal servicing or in standby loss. If exact information is not available, at least a close approximation upon each of these features can and should be determined and used.

If, for example, the locomotive efficiency of the gasoline locomotives is established as 12.5 per cent and it is determined that 4 per cent of the total gasoline disbursement is consumed in terminal servicing and standby loss, the resultant fuel utilization in work performance is 12 per cent of the gasoline disbursed. Likewise, if the locomotive efficiency of the steam power is established at 3.5 per cent and it is determined that 14 per cent of the total coal disbursed is consumed in terminal servicing and standby loss while the locomotive is not working, the resultant fuel utilization in work performed is 3 per cent of the coal disbursed.

Calculation of the coal-gasoline equivalent from these established values would logically follow the same form as that referring to fuel-oil burned in locomotive fireboxes and the formula proposed by your committee would appear as follows:

B.t.u. per ton of coal × coal utilization percentage ÷ B.t.u. per gallon of gasoline × gasoline utilization percentage = coal equivalent in gallons per net ton of coal.

Example: 25,000,000 B.t.u. × 0.03 ÷ 125,000 × 0.12 = 50 **gallons per net ton.**

The two percentages used in the example above may be combined into a single quantity, $0.03 \div 0.12 = 0.25$, which may be considered the "utilization factor of coal relative to gasoline." A range in such a factor from 0.40 to 0.15 would embrace a range in fuel utilization in work performed of from 10 per cent to 14 per cent for gasoline locomotives and from 2 per cent to 4 per cent for steam locomotives.

To illustrate the probable limits of consistent coal equivalent values for gasoline, gallons per net ton, the following tabulation has been prepared for coals of 13,500 to 11,500 B.t.u. per pound and gasoline of 125,000 to 130,000 B.t.u. per gallon.

Gasoline-Coal Equivalent—Gallons Per Ner Ton

Coal, B.t.u. per lb. and per ton	Gasoline, B.t.u. per gallon	Gallons per net ton			
13,500 per lb.	125,000	86	65	54	32
27,000,000 per ton	130,000	83	62	52	31
12,500 per lb.	125,000	80	60	50	40
25,000,000 per ton	130,000	77	58	48	29
11,500 per lb.	125,000	74	55	46	27.6
23,000,000 per ton	130,000	71	53	44	26.6
Utilization factors of coal relative to gasoline		0.40	0.30	0.25	0.15

Diesel Fuel Equivalent to One Net Ton of Coal

The committee proposes the same procedure for the determination of the Diesel fuel-coal equivalent that is recommended for the gasoline-coal equivalent. In this case a range in the utilization factor of coal relative to Diesel oil from 0.25 to 0.10 would embrace a range in fuel utilization in work performed of from 16 per cent to 20 per cent for Diesel locomotives and from 2 per cent to 4 per cent for steam locomotives.

To illustrate the probable limits of consistent coal equivalent values for Diesel oil, gallons per net ton, the following tabulation has been prepared for coals of 13,500 B.t.u. to 11,500 B.t.u. per pound and Diesel oil of 135,000 to 145,000 B.t.u. per gallon.

Diesel Oil-Coal Equivalent—Gallons Per Net Ton

Coal, B.t.u. per lb. and per ton	Diesel oil, B.t.u. per gallon	Gallons per net ton			
13,500 per lb. 27,000,000 per ton	135,000	50	40	30	20
	140,000	48	38.5	29	19
	145,000	46.5	37	28	18.5
12,500 per lb. 25,000,000 per ton	135,000	46	37	28	18.5
	140,000	44.5	36	27	18
	145,000	43	34.5	26	17
11,500 per lb. 23,000,000 per ton	135,000	42.5	34	26	17
	140,000	41	33	25	16.5
	145,000	40	32	24	16
Utilization factors of coal relative to Diesel oil		0.25	0.20	0.15	0.10

Conclusion

It is readily apparent that the proposals advanced by your committee do not represent any wide departure from conventional methods and it seems probable that many roads are now following the procedure fairly closely in working out their coal equivalents, since the values reported by many are of the same general order as the averages of the values tabulated in preceding sections of this report. As to other roads that are reporting the simple ratios between the B.t.u. content of coals and other fuels, it does not seem to be unreasonable to anticipate that they would each be willing, in the interest of uniformity of practice, to give serious consideration to the adoption of the suggested modified method that we are convinced will produce equivalents that are more consistent with the actual comparative performances that are commonly observed in operating practice.

There probably are isolated cases on many railroads in which, due to unusual conditions, extreme values of coal equivalents may actually apply, but it is not considered likely that such cases could be sufficiently extensive to have an important or controlling influence on the average for a railroad as a whole. It would be consistent to give due weight to each such special case in calculating the coal equivalent for each class of fuel or power for a railroad as a whole.

The report of the Committee on Fuel Records and Statistics was signed by E. E. Ramey (chairman), fuel engineer, B. & O.; P. E. Buettell, fuel supervisor, C. M. St. P. & P.; J. G. Crawford, fuel engineer, C. B. & Q.; H. Morris, superintendent fuel and locomotive performance, C. of N. J.; E. G. Sanders, fuel conservation engineer, A. T. & S. F.; W. R. Sugg, superintendent fuel conservation and lubrication, Mo. Pac., and R. J. Tucker, assistant to fuel supervisor, C. & O.

Discussion

John R. Jackson (Mo. Pac.) said that, reviewing the entire subject of fuel equivalents, it would seem that the rapid change now taking place in the situation warrants an entire reconsideration of the method of reporting fuel consumption. This is the result of the growth in the use of liquid fuel. Why not, he said, change the entire approach to the subject and report fuels in terms of the units actually used; that is, in terms of gallons of Diesel oil, in gallons of motor-car gas, etc. He suggested that the committee study the proposal that each type of fuel or energy be reported separately with a view of recommending its adoption. On motion, this suggestion was adopted.

Effect of Steam Distribution on Locomotive Performance

By J. L. Ryan

Mechanical Engineer, St. Louis-San Francisco

The statement has been made by an American authority on locomotive steam distribution systems that there is probably no subject pertaining to locomotives on which there exists wider difference of opinion than the arrangement of the details of the valves and valve gears that control steam distribution. This statement will be substantiated by an examination of the table that lists representative locomotives of recent construction.

Today far greater attention is given to the ton-mile-hour capacity of a locomotive than to its rated maximum tractive force. Mountain type locomotives having 10,000 lb. lower maximum tractive force rating than heavy Mikados on the same division are in many instances doing the better job of the two in handling fast freight runs. With the exception of where heavy ruling grades are encountered and of such length that they are not velocity grades, the horsepower rating has superseded the maximum tractive force rating. Under these operating conditions steam distribution is far more important than it was in the days of drags for freight and relatively low speed for passenger service.

Examples of Valve Data for Locomotives of Recent Construction

Type of loco.	Dia. of drivers, in.	Steam pres., lb. per sq. in.	Cyl. dia. in.	Dia. valves, in.	Valve travel, in.	Max. c.-o., per cent	Steam lap, in.	Lead, in.	Exh. clearance, in.
4-4-4	80	300	17¼	9	6½	84	1⅛	¼	⅛
4-4-2	84	300	19	10	6½	84	1⅛	¼	⅛
4-6-4	80	300	22	11	7½	84.5	1 5/16	5/16	1/16
4-6-4	79	275	22½	14	8½	82	1⅝	⅛	5/16
4-6-4	84	300	23½	13	7	86.6	1⅛	5/16	1/16
4-6-4	84	300	23½	12	7½	84	1 5/16	5/16	⅛
4-6-4	84	300	25	14	7¾	72.6	1⅞	5/16	1/16
4-8-4	80	300	25	12	7	80.8	1⅝	5/16	⅛
4-8-4	75	275	25½	14	7	87.5	1⅛	¼	⅛
4-8-4	74	285	26	14	7½	86.6	1¼	¼	⅛
4-8-4	80	280	26	12	7¼	73.5	1¾	¼	5/16
4-8-2	72	250	27	12	7	80	1 7/16	3/32	⅜
4-8-4	73½	250	27	12	7¼	73.5	1¾	¼	..
4-8-4	74	250	28	14	8	78.5	1¾	3/32	⅛
2-10-4	69	260	29	14	9	80	1 11/16	5/16	0
4-8-2	70	250	27	14	7¾	77.5	1¾	5/16	0
2-10-4	70	310	27	14	7½	85.0	1 9/16	¼	⅛

Two examples are given of locomotives having 1¼-in. steam lap and wide steam lap, detailing the valve events, travel, port openings and port areas for approximately 25 per cent and 50 per cent cutoffs with percentages resulting from application of wide steam lap. Example I gives the results when increasing the steam lap from 1¼ in. to 1 11/16 in., the lead unchanged, the valve travel reduced ¼ in. Example II gives the results when increasing the steam lap from 1¼ in. to 1 15/16 in., the lead and valve travel unchanged.

Representative steam areas from the boiler to the steam chests for locomotives having valves as in Examples I and II are:

	Sq. in.
Dry pipe	67.2
Superheater header, inlet	70.88
Superheater units	70.0
Throttle	70.8
Superheater header connections, each	50.2
Branch pipes, each	50.2

Referring to the two examples, it will be noted that with 1¼-in. steam lap at the short cut-off the areas are 12.25 sq. in. and 10.1 sq. in., respectively, and at 50 per cent cut-off the areas are 22.3 sq. in. and 21.2 sq. in. The areas are those with maximum port opening at the particular cut-offs. One readily appreciates that the average port area for the period of admission is less than the maximum. This is shown on the valve ellipse for the 1 15/16-in. steam lap of Example II for the port opening through the various admission periods. At 25 per cent cut-off the average opening is .716 that of the maximum and at 50 per cent cut-off the average opening is .723 that of the maximum.

At diameter speed the time interval for steam admission at 25 per cent cut-off is slightly less than one-thirtieth of a second (.03 seconds); considering this and the restricted area of the admission port, it is quite understandable why one has difficulty in detecting where the steam line ends and the expansion line begins on an indicator card taken at these speeds.

This brings out rather sharply one of the inherent weaknesses of the radial gears—greatly reduced areas for the operation that has reduced time interval. That the restriction of limited port areas on the work-rate capacity may be partially removed is readily apparent from an examination of the effect of steam lap in the two examples. Without change in the lead, increasing the steam lap from 1¼ in. to 1 11/16 in., Example I, results in 19 per cent greater admission port area at 27 per cent cut-off and 32 per cent greater admission port area at 50 per cent cut-off. The exhaust port openings without change in exhaust clearance, are increased at these cut-offs respectively 30 per cent and 32 per cent. Without change in the lead, increasing the steam lap from 1¼ in. to 1 15/16 in., Example II, results in 30.7 per cent greater admission port area at 25 per cent cut-off and 50.5 per cent greater admission port area at 50 per cent cut-off. The exhaust port openings with change in the exhaust clearance are increased at these cut-offs respectively 50.7 per cent and 53.3

Example I—Effect of Wide Steam Lap—28-In. Stroke

			Per cent increase with wide steam lap
Steam lap, in.	1¼	1 11/16	....
Valve diameter, in.	14	14	....
Valve travel, in.	8¾	8½	....
Maximum cut-off, per cent	89.5	80.7	....
Lead, in.	¼	¼	....
Exhaust clearance, in.	⅛	⅛	....
Exhaust opening at end of stroke, in.	1⅝	2 1/16	....
Exhaust port area at end of stroke, sq. in.	55.2	70.0	26.8
Events at 27½ Per Cent Cut-Off			
Release, in.	18.5	19.1	....
Closure, in.	7.41	7.47	....
Pre-admission, in.	0.66	0.40	....
Valve travel, in.	3.22	4.23	....
Admission—port opening, in.	0.36	0.43	....
Admission—port area, sq. in.	12.25	14.6	19.2
Exhaust—port opening, in.	1.73	2.25	....
Exhaust—port area, sq. in.	58.8	76.5	30.1
Events at 50 Per Cent Cut-Off			
Release, in.	22.125	22.56	....
Closure, in.	4.47	4.43	....
Pre-admission, in.	0.21	0.157	....
Valve travel, in.	3.81	5.11	....
Admission—port opening, in.	0.657	0.867	....
Admission—port area, sq. in.	22.3	29.5	32.0
Exhaust—port opening, in.	2.03	2.68	....
Exhaust—port area, sq. in.	69.0	91.1	32.0

per cent. The increase in the admission port areas and the greater freedom of the exhaust adds substantially to the capacity of a locomotive, and to its economy when considering similar work rates. The higher the operating speeds the more pronounced are the benefits that are derived.

Effect of Valve Characteristics on Steam Distribution

Steam Lap—The most important factor in steam distribution is the steam lap. It determines the travel and velocity of the valve at short cut-offs, causes expansion and pre-release, and has a decided effect on the width of admission- and exhaust-port openings. When the steam lap is extended the following desirable features are obtained: (1) wider port openings for both admission and exhaust; (2) increased valve travel for a given point of cut-off, decreased influence from lost motion; (3) increased freedom of release, resulting in a lower back pressure; (4) less pre-admission for a given lead at all points of cut-off permits using maximum lead for capacity without excessive pre-admission, and (5) higher mean effective pressure at all points of cut-off.

Lead—At the shorter cut-offs the lead vitally effects the maximum steam-port openings obtained. With narrow lap lead in excess of ¼ in. rapidly increases the pre-admission. It is not so critical in this respect with wide lap valves.

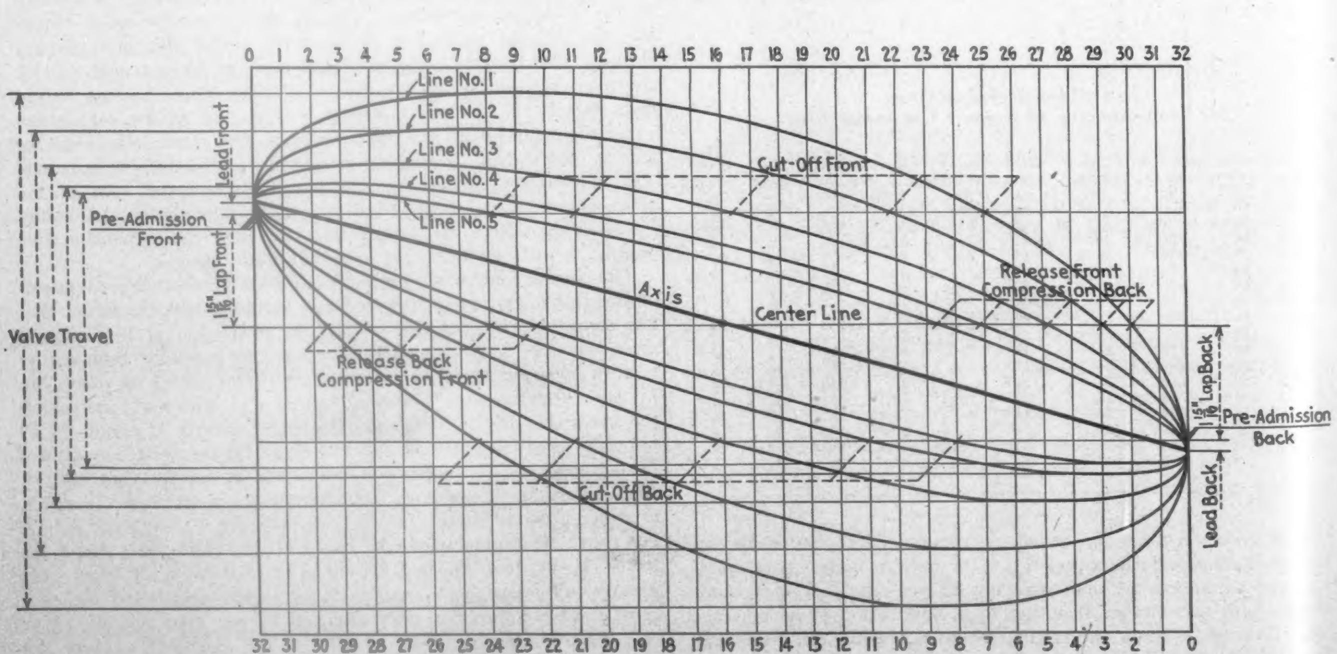
Exhaust Clearance—Exhaust clearance functions on the exhaust side of the valve in much the same manner as lead on the steam side. It not only hastens the release and retards compression, but widens out the exhaust opening. The earlier release results in a thermodynamic loss in the expansion line. With valves having narrow steam lap exhaust clearance is resorted to for exhaust freedom for the higher work rates and to reduce the compression at the shorter cut-offs. It can be dispensed with to a great extent with wide-steam-lap valves.

Long Valve Travel—An increase in maximum valve travel to that which may be termed long travel has no effect whatever on the valve action at the shorter cut-offs, it merely gives a late maximum cut-off. To affect an improvement obtaining greater horsepower capacity it is necessary to take advantage of the longer travel by increasing the steam lap.

Diameter of Valve—The areas of the admission and exhaust ports are in direct proportion to the diameter of the valve used where similar practice is followed in the application of bridges. If the power of the engine is limited at the shorter cut-offs by

Example II—Effect of Wide Steam Lap—32-In. Stroke

			Per cent increase with wide steam lap
Steam lap, in.	1¼	1 15/16	....
Valve diameter, in.	14	14	....
Valve travel, in.	8¾	8¾	....
Maximum cut-off, per cent	89.7	77.3	....
Lead, in.	5/16	5/16	....
Exhaust clearance, in.	0	0	....
Exhaust opening at end of stroke, in.	1 7/16	2⅛	....
Exhaust port area at end of stroke, sq. in.	48.8	71.6	46.5
Events at 25 Per Cent Cut-Off			
Release, in.	22.44	22.87	....
Closure, in.	9.56	9.12	....
Pre-admission, in.	.453	.28	....
Valve travel, in.	3.09	4.65	....
Admission—port opening, in.	.297	.39	....
Admission—port area, sq. in.	10.1	13.2	30.7
Exhaust—port opening, in.	1.547	2.33	....
Exhaust—port area, sq. in.	52.5	79.1	50.7
Events at 50.4 Per Cent Cut-Off			
Release, in.	26.44	26.72	....
Closure, in.	5.56	5.28	....
Pre-admission, in.	.156	.094	....
Valve travel, in.	3.75	5.75	....
Admission—port opening, in.	.625	.937	....
Admission—port area, sq. in.	21.2	31.9	50.5
Exhaust—port opening, in.	1.875	2.875	....
Exhaust—port area, sq. in.	63.8	97.8	53.3



Valve ellipse for the 1 15/16-in. steam lap of Example II

these areas it is obvious that the diameter selected will have a vital influence on the performance.

Design Practices—Four-six-fours having the same general boiler pressure and driving wheel diameters will be found with steam lap from 1⅛ in. to 1⅞ in. and the lead from 3/16 in to 5/16 in. Based on the type of locomotive and driver diameter one may rightfully assume the service assignments to be quite similar. Four-eight-fours will be found with the steam lap from 1⅛ in. to 1¾ in. and the lead from 7/32 in. to 5/16 in. Locomotives of the 4-8-4 type are more susceptible to having a wider variation in their operating demands from one railway to another as one may design for high-speed heavy passenger, another for dual service, and another for high-speed freight. Locomotives of the 2-10-4 type having boiler pressures within the high-pressure range and drivers of corresponding diameter have 15/16-in. steam lap and 1 15/16-in. steam lap.

Suggestions for Dealing with Inertia Forces

The inertia forces in the valve gears vary to the square of the speed. It is quite understandable that, with the recent speeding up of passenger service with steam locomotives designed for diameter speed and with maintenance hardly up to the standard required for the new peak speeds, some valve-gear maintenance troubles were experienced and that to relieve such troubles a trend developed to shorten valve travel with the resultant required short steam lap. To avoid too great a restriction on capacity maximum lead was provided which introduces the objectionable operating effect of excessive pre-admission at the shorter cut-offs.

To remove to the extent reasonably possible the restrictions in the steam distribution in our locomotives at the shorter cut-offs the following procedure would be effective in the right direction: (1) valves of lightweight construction using bronze valve rings preferably of a sectional type; (2) refinement in the design of the valve gear parts, using steels having higher physical properties making an exception of the material in the eccentric rods that are subject to shop adjustment; (3) the providing of more liberal areas in the bearing comparable with the high speed service requirements. Preferably the application of roller bearings as the elimination of the play inherent in friction bearings greatly reduces the shock load on the valve gear, and (4) large diameter of eccentric-crank fit on the main pin with a key having increased proportions.

This will make practical long valve travel and steam laps not less than 1⅝ in. for high-speed passenger service and 1¾ in. to 1⅞ in. for fast heavy freight. The valve diameter should be not less than 14 in. for locomotives where reasonable high capacity is expected.

With the additional admission-port opening obtained with the wide steam lap it is usual practice to provide a lead not exceeding ¼ in. Where the operation requires the greatest possible capacity at the higher speeds an additional 1/16-in. lead would effect a distinct gain without as detrimental an effect from excessive pre-admission as when providing the same lead with short steam lap. Where the peak power demand is at the longer cut-offs and moderate speeds, advantage may be taken of the increased admission-port opening obtained with wide steam lap to reduce the lead to approximately 3/16 in. and exceptionally smooth operation be obtained at short cut-off.

More Power from Old Locomotives

We should not concentrate our efforts on the few new locomotives to the exclusion of the many older locomotives that will be continued in service for a number of years. With the railways taking an ever increasing load from week to week, those of us in the motive power departments should carefully analyze possible sources of power increase.

Where increase in the tractive force or horsepower of existing locomotives is desirable, if the boiler stresses permit, it is common practice to raise the working pressure. This also increases the stresses in frames, crank pins, rods, etc., and in some instances the latter stresses are increased beyond acceptable limits so that the pressure cannot be raised.

There is another source of power increase for operation at speeds above that of starting that is just as tangible in producing operating results as is increased boiler pressure, but that unfortunately appears not to be fully appreciated by many. It is the increase that may be effected in the mean effective pressure at given cut-offs and piston speeds of many of our locomotives without change in boiler pressure. This is brought about by providing more liberal steam admission and exhaust areas for the various cut-offs as previously outlined. Of major consideration is the fact that the boiler stresses and the running-gear stresses from maximum piston thrust are not affected. Some increase should be expected in the maintenance of such items as packing, rod bearings, driving box bearings, etc.

What Expenditure Is Justified?

New Diesel locomotives are costing $80 to $85 per rated horsepower. New steam locomotives for road service are costing are costing $30 to $35 per horsepower, rating the locomotives on the maximum that may be reasonably developed, not on Coles rating.

Assuming a service life expectancy of 25 years for the new steam locomotives, the initial investment is $1.30 per horsepower per year of service-life. Applying this to an improvement to be made in an existing locomotive that has 10 years service expectancy remaining, and assuming that the improvement will increase the capacity of the locomotive 350 hp., the permitted investment would be $1.30 × 10 × 350 = $4,550.

In the majority of instances the changes in the valve gears and related steam-distribution parts that would be required to give approximate maximum results within the range here considered would come within cost bounds of $700 to $2,000. Present design and proportions would necessarily govern the extent to which changes of parts would be required and the increase in horsepower capacity that would result. It is quite possible by changes in the steam distribution systems to add 300 to 700 hp. to the capacity of locomotives that were not carefully designed for maximum power.

Discussion

P. D. Hawkins (Erie) spoke of the so-called compression knock due to the sudden change in the sign of the force at the end of the stroke and the clearances in the rod bearings. Apparently insignificant changes in preadmission port area, he said, have effected very significant changes in locomotive operation at high-speed and short cut-off.

The Steam That Does No Work

By Lawrence Richardson

Assistant to Vice-President and General Manager, Boston & Maine

The best test of any business or manufacturing activity is its efficiency at light load or no load. Almost any company can make money if business is good and orders call for a night shift. Only if it can operate efficiently when the orders get scarce and hours are shortened will it hope to successfully weather business storms. Likewise, heavy traffic will keep some railroads going which, when the curve turns down, are handed to the sheriff.

The real test of efficient locomotive operation is the overall efficiency. Good efficiency while working may be more than offset by poor efficiency while drifting. But on hilly roads, which are the rule rather than the exception, so much fuel is used downhill that a high drifting efficiency is necessary in order to obtain a satisfactory overall efficiency. There are many divisions in this country where 20 per cent or more of the total coal is used in drifting. A halving of the fuel used in drifting will decrease the fuel consumption 10 per cent on such divisions. There are records of divisions where this economy has actually been effected. There are many others where there are similar potential savings.

Smoke Lifting

Why use steam downhill? The principal, and in certain cases the only reason, is to lift smoke. No crew can satisfactorily operate a locomotive with smoke rolling in their eyes. Improvements in front end design—freer nozzles and enlarged stacks—have only added to the problem. But equally as important are the passengers. High-speed trains produce eddy currents proportional to the square of the speed. A train at 70 m. p. h. has twice as much suction effect as a train at 50 m. p. h. The result has been that some of the mile-a-minute trains have had smoke drawn into the air-conditioning system with consequent annoyance to passengers. In fact, some western roads have solved their difficulties by projecting the stack more than 16 ft. above the rail. But only a few roads can do that. Certainly no eastern road can do so with restricted clearances established years ago when power was light and cars small.

The alternative remedy is to design the locomotive properly to minimize the roll of the smoke. Do not misunderstand this statement to mean streamlining. In fact, some streamline locomotives have been guilty of annoying smoke infiltration in the air conditioning system.

There are two cardinal principles to be followed. First, get the smoke up as high as possible. Second, do not have eddy currents to pull it down again. Both problems so far have been largely attacked by cut-and-try methods. The results are largely a matter of individual opinions, always difficult to reconcile, rather than fact. The scientific use of wind tunnels and smoke streams to solve this problem is yet to be done. Nevertheless, the fund of information already collected in the development of modern aviation is helpful.

The second principle is to prevent eddy currents. What good is it to get smoke up and then have eddy currents pull it down again? Here again, the knowledge of airplane design is helpful. Whenever possible, projections should be avoided or streamlined. They should be placed outside the smoke stream area where possible. Changes in dimension should be as smooth as possible. There is also a device which is helpful where there is a tendency to produce eddy currents, a tendency that cannot be completely eliminated. It is the use of vertical plane surfaces to knife through eddy current areas and produce streamline currents. They are sometimes referred to as wings. Successful use has been made of these thin wings in France, Germany and the United States. A recent test on one of our largest railroads has shown them to be the most effective device in keeping smoke from rolling downward.

The better the front-end design, the less steam required in the blower. A poorly designed front end may require a full opening of the blower valve while a well designed front end will only call for cracking of the valve. The difference has an appreciable effect on the coal consumption.

Keeping Valves and Cylinders Lubricated

The other use of steam downhill, (when used), is to aid lubrication and prevent damage to the valves and cylinders. A few roads use by-pass valves, but the majority use steam. Where by-pass valves are used, they must be correctly designed and of ample capacity or they are useless. The German railways use a large by-pass, some 8 in. in diameter. One of the principal western lines in this country also uses the same device. When this by-pass is large, there is practically no compression as the air is free to move back and forth from one end of the cylinder to the other. The lack of compression under certain conditions is a disadvantage, especially if the reciprocating parts need effective cushioning at the end of the stroke. This generally occurs when drifting at speed.

In one design the relief and by-pass features are combined in one valve. In this device, the valve opens when the pressure in the steam chest drops to atmospheric pressure. This move opens ports to the atmosphere to serve as relief ports and also opens passages between the steam chest and exhaust passages serving as a by-pass. Care in shutting the throttle is of assistance in the operation of this valve.

Relief valves have practically disappeared from modern locomotive practice. Hardly a locomotive built in the last twenty years has had them applied. When used, the valves fluttered quite a bit and often failed. Carbonization frequently occurred. These failures contributed in a large measure to their discard.

The large majority of American railroads drift with steam. Those that just let an engine drift without special valves or without using a drifting valve or cracked throttle either do not have long drifts or else are having troubles that they should not have. A test was being run on our road one day and the engineer failed to open the drifting valve. The minute the train crowned the summit and starting drifting, the temperature started rising, reaching a maximum of 825 deg. No oil will stand that temperature. There had been indications of this condition in that the paint had cracked off the valve chamber. After this temperature had been discovered, it was quietly confirmed by an engineman who told of seeing a valve chamber red hot. The explanation is simple. The work done in compressing air must be dissipated as heat. [Mr. Richardson presented a table showing final temperatures for various final pressures of compression. This showed that, starting with air at 60 deg. F., a final air pressure of 250 lb. raised the temperature to 749 deg. F.]

If this compression starts just after shutting off steam, when the cylinder is hot, you end up with air at a much higher temperature. With such temperatures possible, is it any wonder that we find carbon deposits in cylinders? The best of oil will burn under these conditions. My personal feeling is that the bulk of carbon found in valves and cylinders comes from this cause and that rarely, if ever, does it come from sucking in smokebox gas through the exhaust passages. Smokebox gases rarely exceed 600 deg. F. and, when drifting, are appreciably lower.

The use of steam in drifting thus becomes a question of economy. It is entirely possible and practicable to drift with a cracked throttle. The chief drawback to the use of a cracked throttle is the trouble of maintaining a small opening and the difficulty of knowing just how much steam is flowing. A back pressure gage indicates the latter. A throttle 14 in. in diameter cracked 1/16 in. has a steam opening of 5½ sq. in. Tests on one of our Pacifics show that 0.44 sq. in. is sufficient. The comparison is obvious. In plain English, 5 sq. in. out of the 5½ is admitting "steam that does no work."

Some roads use a 2-in. globe valve for drifting to get better control. This gives up to 3 sq. in. of steam opening. There is a feeling on the part of some that it is necessary to prevent any vacuum in the cylinder. The difficulty in accomplishing this lies in the high pressure needed at the start of the stroke. With 7 per cent clearance, 210 lb. is needed. With 10 per cent clearance, 147 lb. It is more economical to work with lower pressures and have a slight vacuum at the end of the stroke, but not enough to bring gas all the way from the smokebox. To minimize this possibility the two exhaust passages should be designed to meet as near the valve as practicable, so that one end can help to break the vacuum in the other end and prevent sucking smokebox gas back into the valve.

The matter of valve and cylinder lubrication while drifting is of paramount importance. Not as much oil is required for drifting as is required for working. But some oil is required. Only a small amount of steam is needed to carry sufficient lubrication to the wearing surfaces.

In general, our experience shows that the proper drifting of locomotives effects appreciable economies in fuel. The amount of "steam that does no work" must be kept to a minimum in order to obtain a low number of lb. of coal for 1,000 gross ton miles.

Much work has been done along these lines. Much more needs to be done. There is no field of locomotive operation that offers the research possibilities that drifting does. The difficulty in the past has been that while locomotive testing plants permitted careful study of the locomotive, they do not work in reverse. They will not drift. When the throttle is shut on a test plant, the speed will drop from 30 m. p. h. to 0 in as short a time as one second. There is practically no drift in such a case.

However, foreign railroads have worked out a method of testing in road service whereby the locomotive is dragged by another locomotive. This permits of scientific study that is so necessary if the drifting of locomotives is to be done scientifically. The Diesel presents no drifting problem. The steam locomotive does. If steam is to keep abreast of Diesels, much research remains to be done.

Discussion

F. P. Roesch (Standard Stoker Co.) recalled some tests which were made during the days of the United States Railroad Administration during the last war on the effect of gases of various

temperatures on lubricating oil. With an oil of 550 deg. flash test, he said, relief valves which admitted air to the cylinders were bad where the temperature of the steam was over 600 deg. The carbonization in cylinders, ports, and valve chambers is not altogether from smoke, he said, but more from the oil itself.

In these tests, he said, it was found that, if the pressure in the steam chests was reduced below 45 deg. F., some vacuum developed in the cylinders, which sucked back air and some smokebox gases. The test developed that a 2-in. pipe would supply sufficient saturated steam to the steam chest to maintain the 45 lb. pressure. After two or three miles of drifting the cylinders would cool down sufficiently, he said, so that the drifting throttle could be closed without danger to the oil.

Mr. Roesch commented on the fact that stacks are constantly growing larger in diameter and suggested that smoke lifting might be improved by making them narrower and deeper along the longitudinal center line of the locomotive, thus reducing the wind resistance and the tendency toward eddy currents behind the stack.

R. M. Ostermann (The Superheater Co.) said that the smoke-lifting function of the steam used in drifting can be effected in other ways, but that the function of protecting the lubrication offers greater difficulties. He asked Mr. Richardson how he would dissipate the heat of friction without the use of steam in drifting.

E. E. Chapman (A. T. & S. F.) told of smoke-lifting tests on the Santa Fe in which a vacuum was found immediately back of the stack. He said that the problem was solved on the high-speed locomotives by the development of an extension stack.

In closing, Mr. Richardson agreed with Mr. Roesch that there is a vacuum in the cylinder at the end of the stroke, but that this is partially broken by pressure in the exhaust at the other end of the cylinder without drawing gases back through the exhaust nozzle. To facilitate this he suggested that the junction of the exhaust passages from the two ends of the cylinders should be as close to the cylinder as possible.

In commenting on Mr. Ostermann's question with respect to the energy which must be dissipated in drifting, he said one test had shown the drag while drifting to be over 400 hp. He also agrees with Mr. Roesch that the present design of stack is incorrect; it should be shaped to reduce air resistance and the vacuum behind the stack.

Report on the Utilization of Locomotives

The Administration at Washington is very much concerned about the possibility that the railroads may not be able to handle all traffic offered, and the Association of American Railroads, Ralph Budd, and other officers have repeatedly called to our attention, that it may be necessary to handle up to 25 per cent more business. We know we can handle our present business. It may work out that the railroads as a whole are not required to handle such an increase. But in certain territories, that increase may be presented, so it would seem that consideration should be given as to whether it is possible to obtain 25 per cent more use of our present locomotive plant, and what means are required to obtain that use.

In the table are shown six-month comparisons of the average mileages of active locomotives per day. These show the following increase in the last five years: Passenger, 13.7 per cent; freight, 9.0 per cent, and switch, 51.9 per cent.

On this basis, considering that passenger trains average 50 m.p.h. and freight trains 25 m.p.h., and, of course, switch engines 6 m.p.h., it can readily be calculated that on all of the roads in the country, the passenger and freight engines are working 4 to 5 hours a day, and the switch engines, 13 hours.

The July, 1941, reports from the 13 largest railroad systems indicate that the following mileages were made by the locomotives on the top two roads and the next four roads in the service indicated.

	Passenger	Freight	Switch
The two roads obtaining the most miles per active locomotive day	300	145	90
The next group of four roads	240	125	84
All roads in the United States	196	117	78

Taking the performance of the two roads that obtain the most miles per day during July, we find the passenger and freight engines working six to seven hours, and the switch engines working fifteen hours. That is, these roads have obtained in road service over 40 per cent more use, and in switch service 15 per cent more use than the average, and when I tell you that the Santa Fe and Union Pacific are the roads obtaining the best mileage in passenger and freight service, you will recall that these roads have, in many instances, been the pioneers in developing long, through locomotive runs.

Going back to the figures for all of the roads, 196 miles in passenger service, indicates a run over two short divisions and the 117 miles in freight service, a run over one division per locomotive per day. It would seem that, even taking the average of all of the engines, it would be possible by close coordination to obtain more than this mileage.

What 25 Per Cent More Locomotives Would Cost

There are, roughly, 34,000 active locomotives in passenger, freight and switch service. It would require the purchase of about 8,500 locomotives to handle 25 per cent more business. Figuring conservatively, at this time, they would cost about $160,000 apiece, which amounts to $1,370,000,000. That is only the locomotives themselves. It would require shops, facilities, etc., to take care of this tremendously increased number of units, because monthly, quarterly and annual inspections are based on the number of units, rather than the mileage obtained per unit. This, of course, is impossible.

Methods of Increasing Miles Per Day of Active Locomotives

The report of the committee last year included the following items:

"Steam switchers have been run 30 days without ever being off the job.

"Passenger engines will make 20,000 miles a month.

"It requires less gray matter to get high mileage out of electric, Diesel, or oil-fired steam locomotives than it does from coal-fired locomotives."

Through Run

A study should be made of each yard operation, to see how many freight trains run through the yard promptly; i.e., go through the yard in approximately an hour. On those trains, the engines should be run through. Then, a study should be made of the rest of the trains arriving and leaving the yard to see if it is possible to match them up so that the departing train will use

Comparison of Miles per Active Locomotive Day for First Six Months

Districts	Miles per active locomotive day 1941	1940	1939	1938	1937	1936
Passenger						
Eastern	188.4	184.9	179.3	175.4	174.2	167.0
Pocahontas	180.0	165.8	172.4	155.9	158.6	158.0
Southern	180.9	171.7	162.0	160.2	162.5	158.0
Western	216.9	207.8	199.3	190.3	198.2	189.9
Total (U. S.)	197.1	190.3	183.5	177.7	180.6	173.3
Freight						
Eastern	114.2	109.4	105.5	101.0	108.7	107.2
Pocahontas	96.4	94.0	85.8	82.6	96.3	90.6
Southern	110.5	99.1	96.2	89.5	99.4	97.1
Western	116.6	107.4	103.4	99.1	112.8	106.2
Total (U. S.)	113.7	106.0	102.1	97.3	108.2	104.3
Switch						
Eastern	82.2	76.2	72.6	67.8	60.2	53.4
Pocahontas	73.2	73.2	66.6	64.2	63.6	58.8
Southern	60.0	57.0	54.6	52.2	48.6	43.2
Western	72.6	67.2	63.0	61.2	52.8	46.2
Total (U. S.)	75.6	70.2	66.6	63.0	56.4	49.8

the engine from a train that has arrived within an hour or an hour and a half.

Then a study should be made and all of a type of power through the enginehouse should be charted carefully to see if the enginehouse foreman "sells out" at least once a day; that is, if he uses everything in the house at least once during the 24 hours. This, of course, does not include the locomotives held for repairs taking 24 hours or over and should possibly, except a protection engine, which he can call on in case some of his regular engines fall down.

It will be found, in general, that it is possible, with the through runs, to put engines back in service after perhaps 30 min. at the enginehouse whereas, if they follow the regular course of coming in on one train and going out on another, it will be found that the turning time may average around five hours.

All of these arrangements having been made just as far as is consistent with good practice, a study should be made of the other runs, to see if it is possible to get the engine from the yard to the enginehouse more promptly, or if it is possible to call the engine closer to the departing time of the train, so as to eliminate as much as possible of the yard delay.

This scheme, worked out at various terminals, has been widely praised by enginehouse foremen because they say that previously when five or six trains are approaching, they had to scurry around and get five or six engines ready, and now they can wait until the first engine arrives, then put the gang on her, and promptly put her back to work; then, when the next engine comes, they work on her. It is much simpler, they say, than producing a half-dozen engines, and then having five or six laying around the house for some time, until you can get them back to work.

The superintendent, of course, will co-operate and will, with his trainmasters and yardmasters, assist in lining up those matched runs.

The next study should be the type of power, because frequently it is found that a lighter engine is held for a light job, and while the light engine is being used, there are some of the heavier engines laying at the enginehouse because of the spacing of trains. In the last analysis, this heavy engine could be used for the light job, and make it possible to eliminate entirely this particular lighter engine.

There frequently is a difference of opinion as to whether the enginehouse actually sells out once during the 24 hours; that is, uses everything but their reserve engines, and that matter can be easily demonstrated—doesn't require any argument—because if the engines, so far as possible, will be used last in, first out, any surplus power will automatically be passed by, and will, by its continued presence in the enginehouse, demonstrate that it is a surplus.

Coal

Many times it is necessary to replace an engine on the train because the arriving engine doesn't have enough coal to go through and the coaling facilities are so far away that the engine can't be returned to the train in time to make the present fast schedules. In that case, it is suggested that a small coaler be placed at a convenient location in the yard, so that when the engine comes with a train, it can be coaled while still coupled to the train. These small coalers have been costing under $1,000, and it will perhaps cost another $1,000 or so to arrange the coaling tracks, so that a complete installation of a coaler that will put on a ton a minute should not run much over $3,000. That, surely, doesn't represent much investment compared to $170,000 for a locomotive.

If it is thought that the ton a minute is too slow, the same type of equipment can be obtained, that will put on two tons a minute, or two of these coalers can be set up in parallel with a slight increase in cost.

Water

Water in large quantities, of course, is essential, and again it is generally cheaper to put a water plug at a convenient place in the yard than to lose the services of an essential locomotive. The total cost of the facility, of course, will depend on how many locomotive hours can be saved.

If we have, say, five runs and can save five hours per locomotive, this is a total of twenty-five hours a day. In other words, we are saving about one locomotive. The saving is not only the first cost of the locomotive but the cost of at least $200 a month that it requires to keep an extra unit in service.

Maintenance

With through running engines, the local roundhouse foreman no longer has a general knowledge of their condition and, therefore, he many times feels reluctant to mark an engine out for a definite time until after its arrival and complete inspection. It is necessary to develop some general supervision over the engines, which will provide adequate maintenance at regular intervals, emphasizing that this is not necessary every 150 miles, but that it is essential at certain periods if long, through runs are going to be practical. This requires a competent inspection organization, and well seasoned foremen, who, from long experience, will know the essential work that is required on a locomotive and who have made a study of the period at which this work should be performed. This should be handled through an organization that is in touch with the entire territory, so that this work can be done after the locomotive has performed a certain amount of service and that records of that performance will be returned to the maintaining enginehouse for their information and guidance.

Reports indicate that to support active locomotives on the road it will require about nine per cent more locomotives which will be found in the enginehouses undergoing periodic repairs. Many times this percentage creeps up but capable supervision can keep it down as low as nine per cent.

Summary

What are we doing? Keeping the machine working about 20 per cent of the time.

What should we do? Keep the road machine working at least 25 per cent of the time. This seems a first class way of showing that the railroads are capable of doing all of the work that the people of the United States require, and that they are capable of doing it promptly and effectively.

It will save the expenditure of tremendous sums of money for the purchase of new equipment, if that were possible, and it will save, also, very substantial sums in maintenance. Finally, it would seem that all that is required to do efficiently the job which the railroad men believe can be done, is the expenditure of a little gray matter in clearly thinking through the details of the problem of the use of locomotives.

The report was signed by A. A. Raymond (chairman), superintendent, fuel and locomotive performance, New York Central; H. W. Bates, assistant master mechanic, C. M. St. P. & P.; E. J. Cyr, master mechanic, C. B. & Q.; E. W. Erisman, general road foreman of engines, Wabash; S. L. Forney, road foreman of engines, M-K-T; O. R. Pendy, general roundhouse foreman, N. Y. C. & St. L.; W. E. Sample, assistant chief of motive power and equipment, B. & O.; and E. G. Sanders, fuel engineer, A. T. & S. F.

Discussion

J. M. Nicholson (A. T. & S. F.) said that a big part of recent business increases have been handled through the more intensive utilization of the motive power already in service. Their freight-locomotive performance in July, 1941, he said, was 27 miles per locomotive per day better than during July, 1940. With a little pressure, he said, a lot more can be done.

W. R. Sugg (Mo. Pac.) called attention to the fact that the increase in the miles per locomotive per day has been accounted for by the increase in speed of freight trains; there has been no improvement in the number of active hours per freight locomotive day.

L. E. Dix (T. & P.) told of some of the difficulties of railroad operation in Louisiana where a large contingent of the U. S. Army has been on field manoeuvers. Where trains are captured and held, he said, not much can be done to increase locomotive-miles per day.

A trainmaster on the New York Central emphasized the importance of giving the mechanical department full information on train movements in advance in order that locomotives can be run through. He said that he did not like to let a locomotive go to the enginehouse at all.

H. W. Sefton (C. C. C. & St. L.) called attention to the misuse of power represented in such operations as keeping the locomotive out of the terminal for one or two hours longer than

should be necessary in order to move a handful of cars from one yard to another.

H. B. Springer (B. & A.) cited as evidence of waste locomotive time the calling of the locomotive and waiting until it has arrived at the train before charging the air brakes from a yard plant available for that purpose. Another way of wasting locomotive time, he said, was requiring all trains to stop for set-outs and pick-ups over the division, instead of confining such service to a pick-up train. He also questioned the need of air-brake tests every 100 miles.

Mr. Springer said that the real job of improving locomotive utilization is one on which all departments should get together in each territory and work out means for eliminating the local causes of delays.

Force Feed Lubrication

Because of more dependable and accurate feeding of oil against pressure, and also because of easier control of the quantity used, force-feed or mechanical lubrication of valves, cylinders and steam auxiliaries has almost entirely replaced hydrostatic lubrication on modern locomotives. The setting of mechanical lubricators to deliver the proper amount of oil to each outlet requires care and study.

Setting Mechanical Lubricator Feeds for Valves and Cylinders

One method proven successful in practice is as follows: By trial and observation on the road, feeds are adjusted to each delivery point so as to provide the minimum oil necessary for proper lubrication. It must be realized that all other conditions being equal, increased average speed requires an increased amount of valve oil, likewise other conditions being equal, an increased average load requires an increased amount of valve oil.

After feeds have been set to provide proper lubrication for one locomotive of each class, the lubricator is then removed from the locomotive, connected on a test rack, which is then operated at a speed corresponding to not higher than the average speed in the class of service in which the locomotive is used, for the number of revolutions equivalent to a twenty-mile run, and the output of oil from each feed measured in a glass cup graduated in liquid ounces. This information is then used as a guide in setting lubricators on other locomotives of the same class.

An important feature of setting lubricators on test racks is the speed of lubricator drive. Most makes of mechanical lubricators increase in pumping efficiency with an increase in speed, therefore if the test rack is operated and feeds set for a sufficient output of oil at this high speed, when the lubricator is applied to the locomotive, the output of oil may be insufficient at low speed.

The practice of setting lubricators on test racks is as follows: First, having performed the necessary mechanical work and cleaned the lubricator, the mechanic operating the test rack connects the lubricator on the test rack, then refers to instructions to determine the number of revolutions of lubricator drive shaft equivalent to a 20-mile run with the locomotive, then refers to a table to determine the number of ounces of oil to be delivered from each feed.

Each feed of the lubricator discharges into a large-mouth glass cup, graduated in liquid ounces. With experience, it is possible to set the lubricator feeds so that it is rarely necessary to make more than two runs with the lubricator before getting feeds set properly.

Under this procedure, it is not necessary to consider the efficiency of each individual lubricator pump, except to be assured that each feed will deliver an excess over that required. In other words, a given lubricator pump may deliver four ounces of oil at given speed, temperature, and number of pump strokes for a given setting of adjusting screw, and another less efficient pump may only deliver three ounces under the same conditions. So long as the less efficient pump will deliver more than enough oil, inefficiency is compensated for by increasing the stroke of the pump.

If the pump efficiency falls below the necessary margin of capacity for valves, it is changed to the cylinder position, then to air pump or stoker position, and finally to a non-pressure position in the machinery lubricator.

Terminal checks of test rack should be set in accordance with manufacturer's instructions.

In order properly to control the use of oil in mechanical lubricators, it is essential that these lubricators be equipped with sight glasses and gages easily read from a position close to the lubricator.

It is recommended that of the total quantity of valve oil fed to a valve and cylinder, from 60 per cent to 75 per cent be fed to the valve, and from 40 per cent to 25 per cent to the cylinder. All excess oil fed to the valve will pass into the cylinder, but excess oil fed to the cylinder will be carried out by the exhaust and wasted.

A second method for determining the oil allowance for valve oil lubricators is also included in this report. As will be noted, this covers both mechanical and hydrostatic lubricators.

Another Method

In the following tables are data for use in setting the feeds of mechanical lubricators for valves and cylinders which were developed after study and experiment. In practice they are said to have reduced wear in cylinders, valves and accessories on locomotives under average normal conditions.

Data for Setting Lubricator Feeds

Type locomotive	Boiler pressure	Rev. of drivers per mile	Cut off, per cent	Miles per hour	Drops per mile per 100 sq. in. per valve and cyl. surface
YARD MINE RUN AND SHORT TRANSFER SERVICE					
Simple engine.....	165-210	350-400	Full	6	1.50
Compound mallets..	180-200	320-360	Full	6	2.50
Compound mallets..	205-225	320-360	Full	6	3.00
Compound mallets..	230-265	320-360	Full	6	3.50
Simple mallets:					
Back eng.	200-215	320-360	Full	6	2.50
Front eng.	200-215	320-360	Full	6	2.50
Simple mallets:					
Back eng.	225-270	320-360	Full	6	3.50
Front eng.	225-270	320-360	Full	6	3.50
LOCOMOTIVES IN THROUGH FREIGHT SERVICE					
Simple	180-200	320	50	20	1.85
Simple	210-225	320	50	20	2.50
Simple (note)	230-270	320	50	20	3.00
Simple mallets:					
Back eng.	200-220	320	50	20	3.50
Front eng.	200-220	320	50	20	3.50
Simple mallets:					
Back eng.	225-270	320	50	20	4.50
Front eng.	225-270	320	50	20	4.50
Compound mallets (lubricate through back eng.)	180-200	320	50	20	3.00
Compound mallets (lubricate through back eng.)	205-225	320	50	20	3.50
Compound mallets (lubricate through back eng.)	230-265	320	50	20	4.00
Compound mallets:					
Back eng.	180-200	320	50	20	2.00
Front eng.	180-200	320	50	20	1.50
Compound mallets:					
Back eng.	205-225	320	50	20	2.50
Front eng.	205-225	320	50	20	1.50
Compound mallets:					
Back eng.	230-265	320	50	20	3.00
Front eng.	230-265	320	50	20	2.00
LOCOMOTIVES IN PASSENGER SERVICE					
Simple	160-180	275	50	30	1.85
Simple	185-200	275	50	30	2.25
Simple	210-240	275	50	30	2.75
Simple	240-270	275	50	30	3.50

Oil Requirements of Accessories

TIME BASIS, DROPS PER MINUTE

	Yard service, 6 m.p.h., drops	Freight service, 20 m.p.h., drops	Passenger service, 30 m.p.h., drops	Local pass. service, 25 m.p.h., drops
Air pumps	2 to 3	4 to 5	3 to 4	4 to 5
Stoker	1	5 to 6	4 to 5	5 to 6
Feedwater pump	1	5 to 6	5 to 6	5 to 6
Intercepting valve	1 every 3 min.	1 every 5 min.	.....	.....
Drifting valve	Local frt., 1	1 every 10 min.	1 every 5 min.	1
Booster	.....	½ idling to 10 in service	⅓ idling to 10 in service	½ idling to 10 in service

MECHANICAL LUBRICATOR, DROPS PER MILE

	Yard	Freight	Passenger	Local pass.
Air pumps	20 to 22	12 to 14	6 to 8	8 to 10
Stoker	6 to 8	15 to 17	9 to 10	10 to 12
Feedwater pump	8 to 10	15 to 18	10 to 12	10 to 12
Each guide feed	6 to 8	8 to 10	8 to 10	8 to 9
Each eng. or t'l'r truck	......	5 to 6	5 to 6	5 to 6
Each boiler bearing	2 to 4	3 to 4	......	......
Drifting valve	......	1	1	2 to 3
Intercepting valve	3	1	......	......

Forced Feed Lubrication of Machinery

Dependable automatic or mechanical lubrication of locomotive machinery is one of the most important factors in long engine runs and intensive utilization of power. In past years this lack of dependable lubrication restricted the length of non-stop engine runs, and to a great extent limited locomotive mileage per day or month.

The wider application of roller bearings has greatly increased the availability of power, but the availability of the conventional bearing locomotive is also greatly increased by automatic machinery lubrication.

On some roads, feeds from the valve-oil lubricator are piped to the most important machinery bearings, such as guides, but on many roads, one or more mechanical lubricators are used for machinery lubrication only. Where separate mechanical lubricators are used for oiling the machinery, a grade of oil most suitable and economical for the purpose can be used.

Oil dividers or splitters have been perfected to the point that various combinations of feeds may be used. By using combinations of dividers, it is possible to lubricate all parts of the machinery desired, using a mechanical lubricator with a comparatively small number of feeds, dividing each feed to as many outlets as may be required.

With proper application of force feed lubrication to such points on the conventional-bearing locomotive as guides, link blocks, engine-truck, driver and trailer hubs, shoes and wedges, and on the roller-bearing locomotive to guides, link blocks, engine-truck, driver, trailer pedestals and flange faces of roller bearing driver housings, together with soft pressure grease lubrication of valve-gear bearings, it is possible to run long distances with little or no difficulty, by filling the lubricators as required at points most convenient. Other bearings such as furnace bearers, radius-bar lifter bearings, and such other points as may be desired can also be mechanically lubricated.

The piping arrangement should be such as to permit of passing a steam pipe from a point at the lubricator along with the oil piping as far as may be necessary to prevent the oil from becoming too cold in winter. One economical way to do this is to use a heater pipe into the heating cavity of the lubricator, and from the lubricator along and wrapped with the oil piping.

The report was signed by W. R. Sugg (Chairman), superintendent conservation of fuel and lubrication, Missouri Pacific; J. R. Brooks, supervisor lubrication and supplies, C. & O.; P. C. Withrow, assistant to chief mechanical officer, D. & R. G. W.; D. C. Davis, supervisor lubrication, A. T. & S. F.; L. M. Griffith, lubrication engineer, Southern Pacific, and J. W. Hergenhan, assistant engineer, test department, N. Y. C.

Discussion

H. W. Sefton (C. C. C. & St. L.) expressed the opinion that with properly lubricated shoes and wedges it should be possible to save from 25 to 50 per cent of rod-maintenance work. When not effectively lubricated, he said, wedges are left loose to prevent sticking, thus throwing additional loads on the rod bearings.

Mr. Wink (A. C. L.), referring to the modern lubricator test rack which that road has installed at the Waycross shops, said that it had been found that, where two feeds come out from a single pump connection on a mechanical lubricator, more oil is delivered from the top connection than from the bottom connection. The effect of the difference, he said, becomes large when the feed is cut down.

The Atlantic Coast Line, he said, had gone into the lubrication of valve-gear bearings. He cited the case of a locomotive which makes 10,000 miles per month for four months on a regular assignment and then is moved around until the same season next year. He said, except for the renewal of one bushing, no valve-gear bearings have given any trouble on this locomotive for two years.

Utilizing Coal of Various Sizes

In giving consideration to the best utilization of the various sizes of coal we must first consider at least two major sources of supply. When the chief source of supply is from company-owned mines, the problem of proper distribution is entirely different than when the coal is purchased on the open market. Let us then first consider the best disposition of coal when the mines are company-owned and from which there can be no sale of any undesirable sizes.

Distribution Problems with Company-Owned Mines

Run-of-mine coal is, of course, the most easily prepared and the cheapest to handle, but is not the best preparation for the various types of locomotives or the various classes of service. In order to get the best possible use from the fuel, some segregation is very desirable.

For the various hand-fired locomotives which are becoming scarcer year by year, a 1¼-in. by 3-in. or possibly a 2-in. by 4-in. egg is the most economical size both for firing economy and for the elimination of objectionable smoke. It is worth considerable effort to bring about segregation to reach this objective, allowing the smaller sizes to go to stoker locomotives and locomotives of larger grate area and fire-box capacity.

During the cold weather the demand for power-house screenings reduces the amount of the smaller sizes that must be consumed in locomotives, but this situation is reversed during the warm weather. At this time every effort should be made to confine the use of screenings to territories where the best possible utilization may be obtained.

Coal From Commercial Mines

Where the supply is obtained from the various mines independently operated as commercial properties, the problem of size utilization becomes somewhat more difficult to regulate because the railroad is expected to serve as a sort of a buffer between the consuming public and the coal producers, making a constantly changing picture. During the warm weather the power- and heating-plant consumption is at its lowest ebb, and during this time many mines ask for relief because of a surplus of screenings. If the pleas of the operators are to be met, there is only one thing to do: remix the screenings with the various sizes of egg and lump coal in order to produce a better mixture and a better locomotive fuel than if screenings were used entirely as such.

During certain times of the year, lump coal becomes a drug on the market and again the railroad company is asked to relieve the situation. In order to protect our stoker equipment, as well as give a better preparation for stoker locomotives, it then becomes expedient to order this coal billed to one of the coal tipples equipped with a mechanical crusher or grizzly bars of proper spacing so the coal can be reduced to an approximately zero by 4-in. size. This causes some extra switching, but the railroad obtains a better fuel by such maneuvering. Sometimes the slump

in the domestic market for lump coal occurs at such a time that some of this coal can well be utilized for station use where lump coal is generally regarded as superior to egg or the smaller sizes for use in the various stoves and furnaces.

When the storage of coal is attempted, the larger sizes are more desirable, as this coal not only stores more safely from a viewpoint of combustion hazards, but also makes a better locomotive fuel after having been in storage for a considerable length of time than would the smaller sizes. It is the accepted practice on many railroads to store nothing smaller than 1¾-in. by 4-in., the preference being 4-in. by 6-in., 6-in. by 8 in. or 8-in. lump.

Segregating Coal Sizes at Various Tipples

On railroads that operate under both of the above mentioned plans, we find that the results obtained by utilizing the various sizes at the various coal tipples are very satisfactory. At the company-owned mines it has been found expedient to install a crusher that reduces the top size to 8-in. This creates some additional fines, but the disadvantage is more than offset by the reduced cost of handling at the various coal tipples and the elimination of switching, especially for clam-shell operation where run-of-mine coal cannot possibly be used satisfactorily.

From an economical standpoint, fuel used by railroads is normally obtained from coal fields at or near the immediate vicinity through which the particular railroad operates. For this reason practically every variety of coal available is used for locomotive fuel. With the more modern railroad coal-handling facilities, where the various kinds and sizes of coal required on the different types of locomotives can be segregated, more economical results can be obtained in the consumption of fuel.

Another factor of no small importance is to make provision to prevent the segregation of various sizes of coal after it is delivered to the bin from which the locomotive tender is loaded. Without this provision, one locomotive tender is supplied with egg or nut coal and the next tender is supplied with an exceptionally large percentage of screenings coal. Obviously under these circumstances the most desirable coal cannot be delivered to the locomotive in each instance.

Best Coal Sizes for Stoker Locomotives

From actual tests conducted in through freight and passenger service, on stoker-fired locomotives, the best results are obtained with coal as placed in the locomotive tender ranging from ¼-in. by 2¾-in. in size. On the hand-fired locomotives better results are obtained when using nut or small egg coal ranging from 2-in. by 4-in. in size.

It has been determined under test that coal larger than 3-in. top size does not distribute properly in fire boxes with grate areas of 80 or more sq. ft. If the fireman adjusts steam jets to distribute the larger size coal over the entire grate surface, the smaller sizes will be carried up against the throat sheet. If steam jets are adjusted to permit smaller sizes from carying over against the throat sheet, the larger sizes will fall short around the distributor or fire pot, resulting in an uneven fuel bed and poor combustion results.

Owing to many railroads using all of the various sized coal on both stoker- and hand-fired locomotives it is felt that the stoker designers have a special duty to perform before delivering new stokers to the railroads. That is to have their engineers make a survey of the coal which is to be handled by the stokers. The conveyor screw mechanism should be of such design that the diameter and the pitch of the conveyor screw will handle the normal run-of-mine coal up to 8-in. lump from shopping to shopping without difficulty.

The tendency on the part of some stoker designers is to furnish a general type of screw conveyor mechanism to handle all grades of coal whether prepared or run-of-mine. This procedure is satisfactory on railroads that prepare the coal or whose coal does not exceed 4-in. top size, but when a railroad contracts for coal up to 8-in. lump or prepares its coal not to exceed 8-in. in size, the stoker designers should take this into consideration and build stokers to suit that size of coal.

With the ever-increasing size of locomotives now being built for use on the American railroads, the majority being equipped with stokers for coal burning, the question of coal utilization of the various sizes is demanding consideration. Where the smaller sizes of coal are available at a price lower than run-of-mine or modified run-of-mine, it would be profitable to make tests of the various sizes compiling your records on a cost basis as well as a consumption basis.

Test Results Favorable to High Proportion of Screenings

A railroad whose entire operation is in mountainous territory has been using the small sizes of coal since 1926 and has each year increased the percentage of small sizes used until in the year 1940, 60 per cent of the total coal used on locomotives was 1⅝-in. by zero, 1½-in. by zero, 1¼-in. by zero, and 1-in. by zero coal. Had the same size coal been used in 1939 as in 1933 at the increased price paid for the coal in 1939, the cost would have increased approximately $16,145.

Better train load, good locomotives correctly drafted, with good grates fitted with precision and properly handled and fired, and a larger per cent of stokers in use were the factors largely responsible for the successful firing of the smaller sizes of coal.

This committee recommends the use of coal not to exceed 2¾-in. in size for stoker-fired locomotives and ranging in size between 2¾-in. and zero. For hand-fired locomotives the size of coal should not exceed 4 in. This recommendation is based on good clean coal which means that the best of cleaning preparations are required at the mines.

It is equally important that the proper fuel sizing and cleaning be considered for stationary power plant furnaces for economical operating purposes. The proper sized coal for stationary power plant furnaces is dependent upon the type of firing appurtenance that is installed in the plant.

The report was signed by S. A. Dickson, chairman, fuel supervisor, Alton; M. B. Adamson, fuel inspector, C. R. I. & P.; P. E. Buettell, fuel supervisor, C. M. St. P. & P.; W. T. Capps, stoker supervisor, B. & O.; J. D. Clark, fuel supervisor, C. & O.; H. B. Grimshaw, fuel supervisor, S. A. L.; S. M. Roth, road foreman of engines, Western Maryland; and W. J. Tapp, superintendent of fuel conservation, D. & R. G. W.

Discussion

In presenting the report Mr. Dixon called attention to a supplement, the data for which were received too late to be included with the advance copies of the report. This supplement was the report of the tests run at the request of the New York Central and participated in by the Pittsburgh Coal Company and Standard Stoker Company. The object was to determine the extent to which coal is broken down in going through the stoker. Tests were made at delivery rates of 7,000 and 13,000 lb. per hr. each with several sizes of coal.

W. R. Sugg (Mo. Pac.) was in agreement with the report on the value of using small sizes of coal not exceeding 2 in. or 3 in., but called attention to the operator's problem of disposing of the large size coal. He took issue with the committee that 2-in. by 4-in. egg coal is the most economical size on hand-fired locomotives. It is all right, he said, so far as operation on the road is concerned, but in terminals the fire can not be properly banked and it is more difficult to keep the locomotive from smoking.

W. J. Tapp (D. & R. G. W.) reiterated the statement in the report based on the experience of the D. & R. G. W. that the smaller sizes of coal are the most economical. He said that, with the increase in the amount of 1⅝-in. by 0 coal used on that railroad, there had been no steam failures and both the cost and the consumption had been steadily reduced.

Frank P. Roesch (Standard Stoker Co.) said that the stoker has to deliver the maximum amount of coal required and must handle any size delivered to the tender. The stoker screws, he said, are adjusted to handle sizes up to 8 in. If made to handle larger sizes, he said, then the delivery rate would be too great at the minimum engine speed. One of the difficulties which had formerly been encountered in the operation of the stoker crew was the boiling out of lumps at the front of the trough in the tender. This, he said, had been corrected. Mr. Roesch said that he was not an advocate of large coal sizes. Stack loss, he said, is caused by vertical air openings in the grates.

J. D. Clark (C. & O.) believes that the sizing of coal for the stoker is important and that it should be done before the coal is placed on the tender. He considers it important to have coal of a sufficiently uniform size so that it will not be broken down by crushing in the stoker. The C. & O., he said, has been using 2¾-in. nut.

G. M. Boh (Erie) inquired of the chairman how coal with

a considerable percentage of fines can be delivered to the locomotive without segregation as the coal drops from the bin into the tender.

Mr. Dixon, in replying to Mr. Sugg's question, suggested that tests should be made to determine precisely what size is needed for use under terminal conditions. He pointed out that two coals of the same analysis may be quite different in their performance, one being smoky and the other relatively free from smoke. This, he said, is a case of the difference in the volatile constituents. One reason, he said, for using larger sizes and not adhering to the small sizes is the high percentage of impurities in the fine coal. To avoid segregation of coal when delivered to the tender, Mr. Dixon said that he had obtained the best results by dropping the coal straight down into the bins. When this is done the lump coal rolls to the sides and, then, when the coal is dropped into the tender, the lumps roll back in again and mix in proper proportions with the fines in the center of the bin. He emphasized the importance of getting rid of large air openings in the grate and of employing something along the line of the Tuyere type grate.

Fuel Economy from the Viewpoint of the Water Engineer

By R. C. Bardwell

Superintendent Water Supply, The Chesapeake & Ohio

At least four problems must be solved in the satisfactory handling of water for locomotive boilers; namely, (1) the prevention of scale, (2) corrosion, (3) foaming, and (4) embrittlement. Experience has shown that the best results can be obtained by giving individual consideration to the practical requirements of the individual supplies rather than to rely on promiscuous dosing of the boilers at the terminals. This has broadened the work of the water engineer to the extent of developing accurate treating plant or proportioning equipment as well as the handling of the application of specific reagents to prevent certain boiler troubles and checking the actual condition of the water in the boilers at terminals to improve operation.

The advancement in the chemical treatment of boiler feedwater for locomotives has been such that the expense and trouble formerly caused by scale and corrosion can be practically eliminated or very materially reduced at nominal cost by the application of the methods which have been repeatedly demonstrated as being suitable for the various conditions. Fortunately, the most practical treatment for preventing the formation of hard and destructive scale deposits, has also been found to be the most effective means for reducing corrosion and pitting. As early as 1912, W. A. Pownall outlined before the Western Railway Club that hard scale can be eliminated by adding soda ash, caustic soda, or equivalent chemicals in sufficient amount to maintain an excess alkalinity over the hardness in the actual boiler water of at least 15 per cent of the total dissolved solids. These conditions can be checked by simple, reliable standardized tests.

The Value of Excess Alkalinity

Because of lack of space and limited clearances on a locomotive, it is not possible to install deaerating feedwater heaters to remove oxygen which is the principal cause of corrosion and pitting. Check by the American Railway Engineering Association Water Committee reported in 1925, indicated that maintenance of an excess alkalinity of 15 per cent would normally restrict the activity of the oxygen and materially reduce pitting and corrosion. With some waters, a higher excess alkalinity is required, even up to 30 per cent of the dissolved solids as reported to the Master Boilermakers Association by Seniff in 1939 for correcting conditions on the Alton. I have personally found it good practice to maintain the excess alkalinity between a minimum of 20 and a maximum of 30 per cent which has materially improved boiler conditions on the Chesapeake & Ohio, the Nickel Plate, and the Pere Marquette.

The treatment of the water may be handled by any one of several different methods, each of which has its advantages and disadvantages. Properly operated lime and soda-ash plants will deliver a clear, soft water with the mud, sediment and organic matter also removed before delivery for use. Soda ash or the wayside method where chemicals are added direct to the storage tanks in amounts sufficient to neutralize the hard scale with no sedimentation, has shown good results at low first cost where competent and careful supervision is provided. Zeolite plants with a clear supply will deliver zero hardness water but trouble has been reported from pitting and corrosion. "Interior" treatment using soda ash or proprietary compounds for direct application to boilers at terminals have improved conditions when followed up under a well supervised plan for checking the treatment in conjunction with a suitable blowoff schedule which will prevent excess accumulation of solids precipitated in the boilers, but this practice appears to be losing favor because of more consistent results obtained where the individual waters are given attention at the wayside stations in accordance with their particular requirements.

Blowdowns

One of the biggest steps in the improvement of locomotive boiler conditions and fuel economy, took place with the realization and effect of proper blowdowns. The advantages were fully outlined in a report to your 1927 meeting by a committee of which W. A. Pownall was chairman, but the acceptance of the idea seemed to be unusually slow by most railroads. This is rather surprising on account of the similarity of conditions when using coal for firing. The lack of understanding was probably due to the fact that the fire-bed can be seen and visibly examined while until the comparatively recent development of practical rapid means for checking the dissolved solids in a boiler water sample at the roundhouse, it was not possible for the terminal forces to know the actual boiler water conditions and whether it was proper to expect continued good operation.

All coal contains more or less impurities. When the pure coal goes off as heat and gases, the impurities are left behind as ashes and clinkers. The occasional shaking of grates to remove the ashes and impurities is taken as matter of course.

However, conditions on the other side of the fire sheets are fully as important. All waters contain impurities of various kinds in the form of scaling matter, alkali salts, or sludge. When the pure water goes out as steam, these impurities remain and concentrate in the boiler. When this concentration of impurities reaches a critical point, the water becomes sticky or "light" and the steam bubbles do not break readily and release the steam but build up on the surface of the water to such an extent that the bubble films and entrained water are carried to the cylinders with the steam and the engine is reported as foaming. It would seem logical that the proper thing to do is to "shake the grates" on the water side of the fire sheets by opening the blow-off cock sufficiently often to remove enough of the impurities and dirty water and replace it with fresh water to prevent this critical concentration from being reached or exceeded.

When proper supervision is being given to water treatment and the satisfactory operation of the water in the boiler, these critical concentration points are determined for the different classes of power over their respective districts. With this information available and knowledge of the water quality and the amount consumed, it is possible to outline blowdown procedures which will replace sufficient dirty water with a fresh supply and prevent the critical concentration from being exceeded. Where this is followed, foaming is eliminated. This practice will permit the continuous operation of the boiler for the full 30-day allowable periods between washouts and the boiler is kept reasonably clean throughout its service.

To operate with the extended washout period, competent supervision and check is as necessary as for any other type of work. It is necessary to know that the blowoff system is in good condition and will work. Then it is necessary to know that the water in the boiler is being maintained in good condition. A good practice is to have water samples taken from each boiler entering and leaving the terminal and tested to determine the concentration upon arrival. This will disclose the attention given

to blowing by the previous road crew, and will permit lowering the concentration sufficiently before leaving to insure a successful ensuing trip. There are now devices on the market at reasonable price and sufficiently accurate which can be used by the regular roundhouse force with a little instruction and occasional check, to make these determinations and give the terminal authorities the same information regarding conditions on the water side of the fire sheets as they have been accustomed to expect of the conditions on the fire side.

With the modern mufflers now available, blowing can be handled satisfactorily at most any location. Devices are on the market which provide for automatic operation of both continuous and intermittent blowdown but most railroads still rely on the intermittent use of the large blowoff cock at designated points or at times which are left to the discretion of the engine crews. One large company has a device which is in the nature of a foam collecting trough which is connected to a blowoff cock that opens automatically whenever the trough becomes filled with water. It is possible that further developments will be made along the line of improving the conditions for handling continuous blows, as results to date, indicate that this is a worth while factor in promoting economical operation of steam locomotives.

Caustic Embrittlement

The other problem in conditioning water for locomotive use is one which has come up within the past 30 years and is connected with the formation of cracks radiating out from rivet holes in highly stressed areas where slight leaks have permitted the high concentration of boiler water solids against the stressed metal. This trouble is only partially due to water conditions but research at the Bureau of Mines which has been financed partly by contributions from the Association of American Railroads, indicates that the trouble can be relieved, to some extent at least, by special treatment of the water supplies which may enter into the trouble at particular locations. Small devices have been designated by the Bureau of Mines laboratory which can be readily applied to a locomotive fire box and will show inside of 30 days if the water is of an embrittling nature.

It has been repeatedly demonstrated that proper water treatment will result in a considerable improvement in boiler conditions which are directly connected with fuel economy. The term, "proper water treatment" means the continuous check of water quality both before and during boiler operation in order to insure that desired conditions are being maintained regularly. Good results by the haphazard, occasional application of chemicals, regardless of type, can only be an accident. If railroads are not in a position to handle their own water treatment with a company water chemist, it is possible to contract this work with one of several commercial companies who are organized and equipped to handle the laboratory tests and the field inspection with the necessary competent check supervision. It is necessary that this competent check supervision be provided, either by company force or by contract, if consistent, good results are to be obtained. It is further necessary that full cooperation between the water chemists and the road and shop forces be carried on at all times.

Discussion

J. R. Jackson (Mo. Pac.) spoke of the tremendous improvement in boiler conditions during the past 25 years and pointed out the possibilities for further economies in the future. He cited the effectiveness of the foam control system in use in the boilers of some of the locomotives on the Missouri Pacific. That road, he said, had been following the practice of blowing down on the road since 1933, with a great improvement in boiler conditions, although there is some question as to its effect on fuel economy. He said that experimental work was under way on the Missouri Pacific to effect a chemical solution of the foaming problem. This, he said, would, if successful, pay large dividends in fuel economy. The blow-down in some cases takes as much as 25 per cent of the water fed to the boiler.

In closing, Mr. Bardwell said that at present there is no economical means to effect the results sought by Mr. Jackson. Research is continuing, he said.

Referring to the waste of fuel in blowing-down, he said that this is not the same as blowing the same weight of water out through the pops, since the water which passes through the blow-off cock has not yet been evaporated and so has not taken up the latent heat of evaporation. Three pounds of water can be blown through the blow-off cocks, he said, with no more heat lost than in one pound of steam blown through the pops.

Car Officers' Annual Meeting

(Continued from Page 409)

The pioneering and presentation of streamliner equipment with its numerous luxuries, modern accommodations and fast operating schedules has met with public favor and consequently we as mechanical supervisors had an obligation to meet in maintaining this equipment in the most exacting manner with respect to safe and on time operation, appearance, repairs and cleanliness. We believe you will agree that critical observations of our equipment will definitely indicate that this procedure of specializing in maintenance work is reflected in the present condition of streamliner trains operating throughout the country today.

The report was presented by Chairman C. P. Nelson, general foreman, C. & N. W.

Discussion

C. T. Ripley, chief engineer, Technical board, Wrought Steel Wheel Industry, said that many wheels are removed unnecessarily from the trucks of high-speed trains because of complaints of hard riding which should not be charged to the wheels. He indicated that slightly worn wheels are often removed for this cause when, in all probability the rough riding was due to some mechanical truck condition or to some out-of-round wheel.

Mr. Swanson said that railroads generally are now changing more wheels than ever before and it is quite a problem for coach yard foremen to know what to do, especially when complaints of rough riding come from people not experienced enough to differentiate between either minor or severe cases of rough riding and, of course, totally unable to help determine the cause. One member said that passengers frequently complain about one car in a train and say nothing about another which is a far "worse rider."

Mr. Swanson also called attention to the increased severity of wheel service on modern high-speed trains and said that on the Milwaukee, some trains have as many as 250 brake applications for curves, turnout and station stops in a distance of 200 miles. He said that the car wheel grinding machine recently installed at Western Avenue (Chicago), has permitted reducing wheel changes on high-speed passenger trains 75 per cent.

(The report was accepted.)

* * *

Photo by W. Curtis Montz

On the Lehigh Valley at Falls, Pa.

L. M. O. A. Considers Personnel and Repair Problems

Two-day meeting at Chicago attracted 113 members who devoted entire time to the presentation and discussion of technical committee reports—New officers elected

THE problems involved in the selection and training of apprentices and several phases of locomotive maintenance work occupied the 113 members of the Locomotive Maintenance Officers' Association during the two-day meeting of the 1941 convention at the Hotel Sherman, Chicago, September 23 and 24. Following a joint session of the Co-ordinated Associations, which was addressed by V. R. Hawthorne, executive vice-chairman, A. A. R. Mechanical Division the first technical session was called to order by President J. C. Miller, general foreman, New York, Chicago & St. Louis.

In his opening address Mr. Miller summarized briefly the events leading up to this years meeting and said further, in part:

"There is a real need in organizations such as ours for painstaking study and investigation which can best be accomplished by committees made up of men from various sections of the country who work under a wide variety of conditions. The gathering and assembling of material in a report is in itself a challenge to the thinking and better performance of those who take part in the project, and when the report is finally discussed by the association and disseminated it is a practical and substantial contribution to the entire membership.

"It is not an easy task to perform successful committee work. Techniques must be developed, unless men are available who have had considerable experience in working on committees for other organizations. Unfortunately, the "lean thirties" deprived most of our members of such experiences. We have a lot to learn in this respect. We may have deliberately to seek for men as new members who can be helpful in this way. If we are alert and open-minded and seriously study how to make our committee work more effective we can overcome the handicap; other related associations have done so and we will do well to study their methods of handling committee work.

"The reports presented at this meeting are the Association's first contribution in the form of committee work. It is not necessary for me to point out that these reports are not a 100 per cent job—they couldn't be, for even Association committees with years of experience do not do a perfect job. These reports are, however, the foundation of something that can be built into an invaluable structure in the years to come. They represent the medium through which data on the variety of practices involved in repairing locomotives can be co-ordinated and presented to the industry in a manner that the industry can use it to advantage. There is no better way in which the ideas of practical men can be brought together and made available to all.

"Regardless of what the future may bring the railroad industry is going to be faced with many problems that are not going to be easy to solve and it is my earnest hope that this Association may continue to show its fitness to be accorded a place among those who will be charged with the responsibility of offering the solution."

The committee reports presented were on the following subjects: Methods for aligning frames, wheels and boxes; apprenticeship; inspection and maintenance of mechanical lubricators; description and operation of HSC air-brake equipment, and a survey of the use of high-speed and carbide tool steels in locomotive machining operations.

In the first-mentioned report the committee presented the details of a suggested method for assuring the positive alignment of the running-gear members of a steam locomotive while undergoing repairs in the back shop and a method by which locomotives can be checked to determine whether or not wheels, bearings and frame are in line as they should be. This report, with drawings, will appear in a subsequent issue. The air brake report presented by J. P. Stewart, (chairman) general air brake supervisor, Missouri Pacific was designed to acquaint the men who will be called on to maintain HSC brake equipment with the equipment itself and the manner in which it functions.

Report on Apprenticeship

In the decade preceding our entry into the first World War, apprenticeship methods on a few railroad systems were so far advanced that they attracted the attention of leaders in industry. Men like George M. Basford, who at the turn of the century and for several years thereafter was editor of the publication now known as the *Railway Mechanical Engineer*, and who was a veritable crusader in the interests of better training; Charles W. Cross and W. P. Russell of the New York Central; and Frank W. Thomas of the Santa Fe, were in great demand at meetings of experts in the field of industrial training. The Canadian railways also maintained the same high standard of thoroughness in apprentice training as had been characteristic of the British railways.

The proceedings of the American Railway Master Mechanics' Association and the pages of the *Railway Mechanical Engineer* and its predecessor, the American Engineer and Railroad Journal, clearly reflect the splendid progress that was being made in improving training practices in the early part of the century. Apprentice training methods on the railroads of North America, in general, were well advanced until economic conditions in the 30's knocked them into a cocked hat, except in a few places, and even there they were slowed down almost to a standstill.

D. S. Ellis,
Chief Mechanical Officer,
Chesapeake & Ohio

O. A. Garber,
Chief Mechanical Officer,
Missouri Pacific Lines

J. Roberts,
Chief of Motive Power and Car Equipment, Canadian National

Advisory Board Members

G. C. Christy,
General Superintendent of Equipment, Illinois Central

J. C. Miller,
President

D. J. Sheehan,
Superintendent Motive Power,
Chicago & Eastern Illinois

J. E. Goodwin,
First Vice-Pres. and Sec.-Treas.

F. J. Topping,
Second Vice-President

S. O. Rentschler,
Third Vice-President

As the position of the railways began to improve in recent years, steps were taken to build up the apprentice quotas and to start restoring the training methods and practices to their former degree of efficiency and effectiveness.

Even though the railroads have been unable to return to the elaborate methods and programs followed by some of them in the 20's, the more essential elements have been retained in most shops, because many of the supervisors of today were trained under those systems in the two decades extending from 1910 to the 30's. Realizing what modern apprenticeship methods meant to them, they are today doing their share in passing on these benefits to the present generation of apprentices. Moreover, it may be remarked in passing that with the trail well blazed, adequate training methods may be promoted today on a less expensive basis than in the days when the art was in the early stages of development.

Increased business, due to the second World War and our own national defense program, brought us face to face quite some time ago with the necessity for taking prompt and aggressive measures to recruit and train young men to fill the depleted ranks of skilled workers. Moreover, improvements in the design and construction of railway equipment, the greater stress under which it is operated, and the necessity for higher standards of maintenance and the working to closer tolerances demand still higher standards of craftsmanship.

The Purpose of This Report

It is not the purpose of this report to attempt to cover apprentice training methods in any great detail. A. H. Williams, general supervisor of apprentice training of the Canadian National Railways, did a splendid job in this respect in a paper which he presented before our association two years ago. Our committee has confined its studies largely to what it considers to be the more vital aspects of the problem that seem to demand special consideration at this time.

Nor, on the other hand, has the committee considered any emergency measures to supply semi-trained workers or "specialists" for "the duration." If that does become necessary on the railroads it may be best to co-operate with other local organizations that have pioneered in this respect and have been carrying on intensive training measures in various parts of the country, in some instances for many months.

The railroad equipment maintenance forces are already beginning to suffer from the inroads on their skilled forces by other industries, and also because of the effect of the selective service draft. Mechanics trained in the locomotive repair shop in the past three decades have been in demand by industry in times of economic prosperity or under war conditions, because the all-around training received in the railroad shops has developed much better mechanics than those trained in the more highly specialized manufacturing plants. In the case of the selective service draft, judging by the experience of some few railroads, the draft board when called upon to do so have not hesitated to put skilled railroad workers in the deferred classifications.

What Are We Striving For?

In a broad way, what is the aim or objective of the railroad mechanical department in its apprentice training program? It can best be expressed in a few words and in a simple and terse way. *It is to insure an ample supply, but not a surplus, of capable, well-trained mechanics in each of the several crafts employed in the locomotive shops.* From this group, over the years, a certain percentage of men having leadership capabilities will be advanced to supervisory positions, at which time they will require additional special training; this, while important, is incidental to the apprentice training program.

Essential Factors of Apprentice Training

What factors must be given consideration to insure the proper training of well rounded-out mechanics?

(a) Obviously the basis of such training is thorough experience and training in the shop, on the various jobs and types of work involved in the particular trade.

(b) The apprentice must receive some related training in mathematics and blue print reading. He should also be given information as to the parts which go to make up a locomotive and how they function, as well as other technical data related to his craft.

(c) In order to develop the young men to their greatest capabilities, certain outside or extra curricula activities should be encouraged.

How Many Apprentices?

Labor union agreements with the railroads indicate a considerable variety in the allowable percentage of apprentices to mechanics. There can be no question but that it is to the advantage of both the labor unions and the railroad managements to insure a sufficient number of graduate apprentices, so that there may be no shortage in skilled labor.

The exact percentage allowable has been the cause of much discussion and there have been strong differences of opinion because of the difficulty in establishing any formula which would take all of the various factors into consideration to insure a steady supply of new skilled workers to meet changing conditions or to take the place of those who drop out of the service for one reason or another. Naturally the most troublesome problem has been to allow for business cycles. That, however, is not peculiar to the railroads.

It is unfortunate that at the very time when more apprentices should be added at the depth of a business depression to take care of the business revival following, it has not seemed feasible or advisable to make such additions. On the other hand, at the peak of prosperity the tendency has been to increase the number of apprentices, which sometimes results in having the largest numbers of lads completing their time when employment conditions may be at their very worst. It is doubtful if any way can be found to remedy this situation, except to make greater and greater efforts to stabilize employment and to dampen the swings in the business cycle. That is beyond the power of the railroads to control, but American leaders (not politicians) are seeking to find ways of solving this baffling problem, and undoubtedly will make progress in the days to come.

It is worthy of note, however, that some railroads in recent years have made great progress in stabilizing employment among their equipment maintenance forces.

Your committee has been greatly impressed with the policy that has been followed for several years by the Canadian National Railways with a view to more or less accurately and scientifically determining the number of apprentices that should be added in each trade throughout each particular year. In other words, the attempt has been made to train only that number of apprentices that can be retained in the service of the railroad at the completion of their apprenticeship and to provide for the normal separations from service each year. To do this, accurate records have been compiled and careful surveys are made periodically.

Workers on that system are retired at a specified age and it is, of course, not a difficult task to determine how many of the men at present employed will reach the retirement age in any given year. Statistics are also kept up-to-date as to the rate at which craftsmen are separated from the payrolls because of deaths, resignations, dismissals, promotions to supervisory positions which remove them from the craftsmen's payroll, etc. Except for unusual contingencies or business cycles, it is possible in this way to make a fairly close approximation of the number of new men that must be added in any one craft in any one year, for a number of years to come. Allowance must, of course, also be made for the number of apprentices who start, but who are eliminated during the probationary period, or fall out for various reasons before they are graduated.

There are, however, certain other factors that must be taken into consideration if a high standard of training is to be maintained. It is a mistake to add too many apprentices at one time. They should be inducted into service continuously, the rate of induction being so controlled that the training will proceed in an orderly manner and in such a way as to insure that each apprentice is moved regularly from one class of work to another and is given a thorough training. If the attempt is made to add too many apprentices at one time, the routine may become clogged up and the individual apprentice may not receive adequate instruction.

The Problem of Selection

Too much attention cannot be given to the proper selection of apprentices to insure as high a quality of skill and craftsmanship as possible. From the standpoint of morale, both managements and the labor unions feel that a very considerable per-

centage of the apprentices should come from the families of employees. Many of the labor union agreements require this. It should, however, not be allowed to interfere with selecting men who are well qualified for the particular kind of work for which the selection is made. A lad ought not to be employed just because he needs a job or is the son of an employee, regardless of whether he is suited to the work or not. If this is done it is an injustice to the boy, and works out to the disadvantage of both the labor unions and the employer.

The age limits in some of the agreements are too low. State laws and the fact that the standards of preparatory education have advanced, in general, over the years, would seem to make it advisable not to take into the service young men under the age of 18, and the top age might well be extended to as high as 23, or even above.

Railroads in recent years have found no difficulty in getting all of the young men they need with high school or vocational school diplomas. The young men are required, of course, to pass physical examinations, and more and more roads are giving intelligence and aptitude tests. While it is true that judgment must be used in applying such tests, there seems to be little question but what they are helpful in making it possible to check on the selection of young men of the right calibre.

It has been found good practice, also, in examining and checking up the young men, to consult their high school and vocational teachers and instructors. It is not enough to have the scholastic records of the young men. Their personalities and habits should be inquired into and this can best be done by talking about them informally with the high school and vocational school authorities.

More than this, however, it has been suggested that the railroads should not wait for the young men to come to them, but rather should go to the high schools and vocational schools to find the men who are specially suited for particular jobs on the railroads, and urge them to enter the railroad service. As one authority suggested, "If we want the best material we must seek it out."

Probationary Period

There has possibly been too much laxity in some places in making close and critical check-ups during the probationary period. The young men are hired in the expectancy that they will spend a lifetime in the service of the railroad. If it is found they are not well fitted for the work or adapted to it, they should be eliminated during the probationary period. It must be admitted that as more and more attention is given to the careful and critical selection of the young men in the first place, there is less and less possibility of having to drop them out during the probationary period.

One tendency that should be guarded against has been noted in a few instances. Some of the young men take particular pains to make a good showing during the first six months of their employment and then when they have passed the probationary period, may be inclined to slow up or slack down. Men of this type, of course, are not desirable; this simply emphasizes the fact that character and disposition must be taken into careful consideration in making the selections in the first place.

Shop Instruction

Close adherence should be given to the routing or scheduling of the apprentices during their entire courses. They should spend the specified time on every machine and on every phase of work included in the program for their particular trade. It is to be feared that unless special precautions are taken, the shop authorities, in the interest of production, may not make the shifts on schedule and the young men may suffer thereby. This is only one of several good reasons why there should be shop instructors at each important point, not only to check up and see that the apprentice is given the proper instruction and coaching in the shop work, but that he is routed according to schedule.

As an interesting sidelight, the presidents of the apprentice clubs on one system make checks, as officers of the clubs, and bring to the attention of the shop authorities any deviation from the schedules.

There is little question, also, but what the schedules for apprentice training in the locomotive shops should be reviewed occasionally and possibly be readjusted. Some schedules, for instance, do not ordinarily give the boys experience on the erecting side of the shop until well along in their apprenticeship. There are some who believe this to be a serious error. It is advisable, as quickly as possible, for the apprentice to understand how the various parts of the locomotive function and how they are put together. If, early in the game, and possibly 60 days after he starts in his apprenticeship, he can be assigned to the erecting side for a period of six months, he will secure this information and can do a much more intelligent job when he handles a particular part on the machine side.

One apprentice supervisor makes a practice of having the apprentices in groups visit the greased test track when locomotives just out of the shop are checked and broken in. They watch the locomotive pass by with the drivers revolving at high speed. Then, one by one, they are permitted to ride on the locomotive. To a lad they are astonished at the extent of the vibrations, and inquire as to whether the locomotive jolts and vibrates as much in actual service—which it does if it is badly out of balance, which defect is, of course, remedied before it goes on the road. There is no question but that the apprentices use more care in fitting bolts and parts on the locomotive after such an experience, or that they realize the necessity for care and accuracy on any work that they may do, either on the machine or erecting side of the shop.

Another device that has been used successfully by some instructors is to give the individual apprentice a series of questions when he has worked in a particular department, which will familiarize him with the different parts and give him a better idea of their functioning and service.

Related or Technical Instruction

There seems to be no question but that a considerable amount of related instruction should accompany the training and experiences in the shop. This includes mathematics, mechanical drawing, freehand sketching and technical information related to the trade. The apprentice should also understand such special rules or regulations, company or government, which pertain to his job and to a certain extent, also, to the equipment on which he works. To some degree this may be covered by talks or discussions led by shop specialists or service men associated with the railway supply manufacturers. Obviously this related study should be as closely co-ordinated as possible with the apprentice's work in the shop.

Some of the railroads give this related instruction in a classroom on company time, with the understanding, however, that assignments will be made calling for the expenditure of about the same amount of time in study outside of work hours. In other instances the apprentices meet in classrooms on their own time. On still other roads they do not meet as a group, but turn in written work and confer as individuals with the apprentice instructor at more or less regular intervals. Occasionally in such instances the group may get together for special programs.

A few roads have developed their own educational material or courses. In other instances it is purchased from concerns which specialize in preparing texts and also in checking and grading the lesson papers and assisting in supervising the training. The task of preparing the texts for a large number of trades and keeping them up to date is such that the tendency seems to be to depend more and more upon outside sources for this material. It will always be desirable, however, to make sure that it takes into consideration special standards or practices of the particular

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Officers Elected for 1941-1942

President: **J. E. Goodwin, master mechanic, Mo. Pac. (I.-G. N.), San Antonio, Tex.;** ***first vice-president:*** **J. E. Topping, master mechanic, C. & O., Hinton, W. Va.;** ***second vice-president:*** **S. O. Rentschler, general foreman, locomotive shops, Mo. Pac., Sedalia, Mo.;** ***third vice-president:*** **C. D. Allen, master mechanic, C. & O., Silver Grove, Ky.;** ***secretary-treasurer:*** **C. M. Lipscomb, Mo. Pac., North Little Rock, Ark.** ***Executive Committee (elected to serve two years):*** **W. E. Vergan, supervisor of air brakes, M-K-T, Denison, Tex.; G. A. Silva, shop superintendent, B. & M., North Billerica, Mass.; G. E. Bell, general foreman, I. C., McComb, Miss.**

railroad. There seems to be a growing tendency, also, to have such instruction and study done outside of working hours, thus preventing interference with the shop operations and production.

In some instances, where the facilities are available, the apprentices enroll in public night schools, particularly where the students in these night schools are largely railroad shop employees. Railroad shopmen and supervisors are frequently engaged as the instructors in such night schools.

It will thus be seen—and it is quite to be expected—that there are a variety of methods for giving this related or technical instruction. Some roads prefer one type; others, with different points of view or facing different conditions, prefer another. It has been suggested that no apprentice training program can be wholly successful or efficient unless the technical training or related instruction is based on a required study schedule.

The important thing—far more essential than any particular method or practice—is that the leaders of the department be sincerely interested in the training and the welfare of the young men in their charge. The right attitude on the part of the officers and supervisors, and the right kind of apprentice supervisor or instructor, may mean far more than the methods of instruction. This does not mean that the training schedule should not be strictly adhered to, or that essential details of the program as a whole should not be closely followed. It does mean that a wise and tactful apprentice supervisor with a liking for young men, and strongly supported by his superiors, *is the prime essential.*

Building Men

Workers will put forth their best efforts when they are interested and happy in their work. No two men are alike. Each one of us has a peculiar individuality and special capabilities, good and bad, which may lie dormant, or may be developed under favorable conditions. The ideal of American democracy is to develop the good talents of the individual to the utmost of his capabilities. This cannot be done in a mechanical way. It requires a careful study of each individual and his peculiar temperament. Incidentally, this is one of the strong reasons why the railroads profit from having apprentice supervisors and instructors, who can carefully and critically study and deal with each individual.

It is not meant by this to infer that the wise and tactful foremen and supervisors do not have their contribution to make to this particular phase of the problem, but ordinarily their routine duties and other responsibilities do not give them adequate time for entirely taking over this responsibility.

With this thought in mind, there is another phase of apprentice training that can be most helpful in developing the young men. It might well be termed extra-curricula activities carried on outside the shop, or outside the classroom, and not taken into consideration in the related technical training. This activity exists in several forms and need not follow any one special pattern.

An apprentice club, for instance, with the apprentices as the officers and with an apprentice instructor or some interested person or group in an advisory capacity, has been found to give excellent results. Here the boys can develop their leadership abilities, can secure practice in conducting meetings and taking part in them, and can find real inspiration and instruction of a broader type as well. They can vary their programs by occasionally bringing in speakers from the outside, either railroad men or railway supply representatives; they can carry on their own social, recreational or athletic programs; they can study about the place that transportation plays in our economic and social life, and particularly as to the part that the railroads are qualified to fill. This will not only intensify their interest in their particular crafts, but will help them to develop along broader lines and become strong and intelligent workers and citizens. Some of these clubs have even exercised an influence for good in local community affairs.

The AREB or American Railway Employed Boys Clubs, sponsored by the Railroad Y. M. C. A., have inspired the young men to high ideals of service. In whatever form such activities are conducted, they are an important and really essential element in the training program, although of a more or less, or even entirely unofficial character. Your committee in its studies and thinking has characterized this particular part of the program as "building men"—helping each individual to make the most of his particular talents and personality.

Sympathetic foremen, apprentice supervisors and instructors, and mechanics, have always been faced with the problem of advising the young men who come to them with their personal problems. They have had to act as "daddies" in a way—and frequently more effective than real "daddies" could have done.

A new phase of this problem has come to the fore in more recent years, since the lads have been better paid and are of a higher average age. Many of the apprentices now get married, and some of them fairly early in their apprenticeship. Young and inexperienced as they are, they sometimes have serious home difficulties, and more often than not these are of an economic nature. More than one apprentice supervisor has found when he diplomatically followed through on an apprentice who was not giving a creditable performance, that the difficulty was back in the home. One wife of an apprentice supervisor made a big place for herself in the hearts of the young people by getting acquainted with the wives of the apprentices, bringing them together, and helping them with their domestic problems. While this has no place in the formal apprentice training program, it does emphasize the necessity for dealing with this whole problem on a broad basis. It is not easy to evade the challenge that faces squarely those engaged in any serious attempt to educate young people in any field of endeavor—the responsibility of helping to "build men."

Merit Incentives

Americans always respond to competition—to the spirit of playing a game. There is much to be said for injecting certain incentives into the training to encourage the young men to put forth their best efforts.

The mere mention of a few things of this sort will suggest others. They may include assignment to help on special tests, even to making road trips on a dynamometer car. A trip over the division in the locomotive cab, assisting the fireman, will emphasize the stress to which the locomotive is subjected and the need for first-class work in its repair and maintenance—and the apprentice will get a real "kick" out of the adventure.

Then there are assignments to the mechanical engineer's office for a spell at blueprint making and drafting; accompanying and assisting an inspector at the works of the locomotive builder; or being detailed to a special shop for work on Diesel-electric locomotives. There are also such items as appointment on the shop committee on safety, or helping to pilot groups of "fans" on a shop visitation. These are only suggestive of the wide variety of incentives that may be developed with a little thought and study, and they certainly do produce results in stimulating a broader interest and more intelligent effort on the part of the young men.

Can anyone estimate the effect of that gathering of about a thousand people at Sayre, Pa., on the Lehigh Valley, when the apprentices were the dinner guests of the community; when the President of the road complimented them after the work and study performance records of about twenty of the leaders had been shown on the screen?

Keeping Track of the Apprentices

What kind of records are kept as to the progress and accomplishments of the apprentices? Are they left largely to themselves and allowed to drift along unnoticed? Are they rated more or less mechanically and only on their written work? Is any record kept of their shop performance, or of their capabilities?

Naturally, here again, there are a variety of practices. On some roads each foreman is required to report periodically on the performance of the apprentices, usually when they have completed their assignments on a particular class of work. Such reports are comprehensive enough to gage the personality of the apprentice, as well as his work performance. While not so intended, they also gage the supervisor's personality to a certain degree, when a comparison is made of the reports of several of them on the same young man. This, however, is a bit beside the question.

Let us consider three types of such reports that are made periodically for each apprentice. The Canadian National grades each young man on four qualities, allowing 10 points as the maximum for punctuality, 20 for initiative, 20 for discipline, and 50 for ability. There must, of course, be a common understanding as to just what is meant by these four expressions.

Punctuality is defined as the quality of being punctual, characteristic of keeping the exact time of an appointment or engagement.

Initiative is the power of commencing, going ahead.

Discipline is defined as mental or moral training, education, subject to control, to train to obedience or efficiency.

Ability is the power to perform, skill to achieve, capability for carrying out, capacity to devise, receive, retain, talents or gifts.

By way of contrast, the Louisville & Nashville has a somewhat different series of characteristics. The apprentices are rated "above," "normal" or "below" on the following ten abilities:

Dependability: Prompt, trustworthy, reliable.
Attitude toward work: Interest.
Ability to catch on: Learns fast, profits by experience.
Safety: Works safely, avoids "horseplay."
Quality of work: Accuracy.
Quantity of work: Speed.
Reaction to criticism: Co-operation.
Initiative: Leadership.
Perseverance: Persistent.
Congeniality: Ability to get along with others.

The Lehigh Valley grades on still another combination of characteristics and also on the quality and amount of work performed. The foremen report monthly on each apprentice, grading them poor, fair, good or excellent on the following ten items: Interest, initiative, industriousness, personal neatness, conduct, ambition to learn, ability to learn quickly, craft skill, observance of safety rules, and co-operation. They also indicate whether the quality of work is better, equal, or inferior to that of the average mechanic; and whether the amount of work is more, equal, or less than that turned out by the average mechanic.

What an asset to good management to have such rating systems in effect!

The Apprentice Instructor

A question frequently asked, and not easy to answer is, "What are the qualifications of an apprentice instructor?"

Many qualities are required, and we shall not attempt to catalog them. We might get lost in the forest because of the great number of trees, and then, also, certain compromises will have to be made in most instances. There are not enough 100 per cent men available.

Some few special talents, however, are essential. He must be a first-class mechanic. He must have a fairly broad background, a keen sympathy and liking for young men, and qualities suited to teaching and leadership. Leadership, not in the sense that he must be a boss, but rather that he should inspire the young men to assume the largest degree of initiative of which they are capable. He must be willing to make sacrifices of time and energy in the effort to help and inspire the young men. Such unselfishness is usually found in men of strong spiritual convictions.

Small Shop Problem

It is difficult to give the apprentice a well-rounded training in the small shop. On some of the larger systems it is the practice to transfer the apprentices from the small to the large shops for part of their training. On other roads no apprentices are maintained at the smaller places, all of the training being done at the larger shops.

The small road, with comparatively small shops, is a special problem. The solution must depend on the ingenuity of those in charge. The duties of the apprentice instructor may have to be combined with those of the foreman, or a specially well qualified foreman. The technical or related instruction may have to be arranged for by correspondence methods, by using local vocational training facilities, or by some other method. Here again no one pattern will suffice; it is necessary to adapt the methods to the peculiar conditions in the particular locality.

"Refresher" Courses

Under the quick tempo of modern developments in industry and transportation, a mechanic may become obsolete, just as does a machine or piece of equipment, unless he makes some effort and is given some assistance in keeping up with his craft. This is all the more true when we consider that some of the mechanics now in service never did have a thorough training (in the modern sense) in their craft.

Labor union leaders, as well as representatives of management, realize something of the seriousness of this problem. At least one ambitious effort was made to give courses which would be helpful to the older mechanics. It was not a very great success, but in light of later consideration, perhaps that is not to be wondered at. The course was too long—it smacked too much of school and older men don't like the implication of going back to school—the methods, perhaps were not adapted to the adults who were far from their school days.

It has been suggested that a short, intensive, peppy course be given, using the best attention getting devices. And more important, that it not be called a school or vocational course, but be tagged by some more attractive and descriptive title—a "refresher" course, for instance. We suggest further study and experimentation in this area of training, which, however, does not come within the scope of the task assigned to us.

Summing Up

Summing up, successful apprenticeship training depends upon the spirit behind the enterprise. It cannot be narrow, nor mechanical in spirit. It must have warmth and it must aim to build men in a broad sense, and to help make good citizens of them. This training comes at a formative period in the young man's life, as he is about to assume his civic responsibilities in our great representative democracy. He is away from his public school and beyond its control. No special agency for training in citizenship has yet been set up, except in a few places, although recent years have seen a tendency in that direction. Certainly his interest should, at least, be challenged in that direction.

The apprentice training program and direction must be such that it will insure the young man a thorough training in his craft, with an understanding as to how it fits into the actual operations of his individual railroad and the equipment which he helps to build and maintain, and also into the great system of transportation as a whole.

He should be so coached as to understand that in this era of technological advance he must have as broad a training in his craft as possible, and must keep up with its development in after life, so that he can the more readily adapt himself to new and changing conditions.

The report was signed by Roy V. Wright, (chairman) editor, *Railway Mechanical Engineer,* New York; C. P. Brooks, mechanical engineer, Erie, Cleveland, Ohio; Elmer Butler, assistant production engineer, Missouri Pacific, Little Rock, Ark.; Thomas C. Gray, chief engineer, Franklin Railway Supply Co., Inc., New York; William W. Haggard, general foreman, locomotive department, Atchison, Topeka & Santa Fe, Topeka, Kan.; W. V. Hirerman, assistant to superintendent motive power, Chesapeake & Ohio, Richmond, Va.; F. K. Mitchell, assistant general superintendent motive power and rolling stock, New York Central, New York; T. B. Roberts, supervisor of apprentices, Lehigh Valley, Sayre, Pa.; H. J. Schulthess, chief of personnel, Denver & Rio Grande Western, Denver, Colo.; A. A. Welton, apprentice instructor, Louisville & Nashville, Louisville, Ky.; and A. H. Williams, general supervisor of apprentice training, Canadian National, Montreal, Que.

Discussion

The discussion of this report brought out the fact that the supply of well-trained mechanics for railroad work is practically exhausted and that steps must be taken to build up a training program. Members from two roads that have pursued a constructive apprenticeship program all through the years of the depression, reported that they now find themselves in a very favorable position as regards skilled help; in fact, their roster of furloughed men has provided a backlog of men that are now serving industry and government in defense contract work.

Much was said about the selection and training of apprentices. Member after member spoke emphatically on the need for great care in picking out the boys that are to be trained; one speaker said that his road had found it worth while to follow a boy's work through school in order that the dead timber might be weeded out at the very start. Interest in the apprentice, on the part of the supervisor, is an exceptionally important factor, judging from the remarks of several speakers. A supervisor should find out what a boy is fitted for, what he wants to do

(and make a thorough check to make sure that he knows) and then follow his work through the training period to assure that proper progress is being made. The importance of practical assignments was brought out by the speaker who said "Give the boy a real piece of work; not just a job."

Other speakers discussed the ratio of apprentices to mechanics and the indication was that the members were not entirely satisfied that the one to five ratio is the proper answer. While no conclusion was reached during the discussion it was brought out that the Canadian National's system of anticipating retirements and normal turnover gave a basis for determining the number of new apprentices that should be inducted into service each year.

Other speakers said that four-year, three-year and even two-year men had been advanced to journeymen during this emergency and one road reported the promotion of helpers to mechanics jobs in which, however, they hold no seniority or displacement rights.

Report on Shop Tools

In view of the increasing use of tool steels containing such alloying elements as tungsten, tantalum, molybdenum, chromium, vanadium and cobalt, the Executive Committee of this association considered it worth while to explore the use of modern tool steels for the machining of locomotive parts with the idea of finding out to what extent railroad shops had adopted these

Table III—Machine Operation Data—Locomotive Parts

		Machine tool data						With tool steel formerly used					With tool steel now used				
Road symbol	Name of part and material	Capacity; make; type	Age yrs	Motor hp.	Machine cond'n.	Oper. No.	Description of operation	Tool steel used	Speed fpm.	Feed in.	Time per piece h.m.s.	No. pcs per tool grinding	Tool steel used	Speed fpm.	Feed in.	Time per piece h.m.s.	No. pcs. per tool grinding
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
AA-4-1	Valve bull rings - Hunt-Spiller iron	24-in. Cincinnati engine lathe	10	10 dc	Good	1	Roughing	Rex AA	33	.037	2-30-0	1	Rexalloy	60	.030	1-30-0	10
						2	Finishing	Rex AA	33	.037	0-30-0	1	Rexalloy	70	.030	0-45-0	10
AA-4-2	Valve rings (blank) - Hunt-Spiller iron	24-in. Cincinnati engine lathe	10	10 dc	Good	1	Roughing	Rex AA	33	.037	7- 0-0	1	Rexalloy	60	.030	5- 0-0	10
						2	Finishing	Rex AA	33	.037	3- 0-0	1	Rexalloy	70	.030	2- 0-0	10
AA-4-3	Steel wheels	55-in. engine lathe	35	15 dc	Fair		Refacing hubs	Rex AA and grinding	15	.085	6 to 8 hours	10	Firthite	75	.085	1-30-0	1
AA-4-4	28-in. Piston bull ring - Cast iron	60-in. Niles-Bement-Pond boring mill	35	13 dc	Fair	1	Roughing	Rex AA	29	.050	4-30-0	1	Firthite	63	.032	3-30-0	40
							Finishing	Rex A	40	.050	3-0-0	1	Firthite	80	.032	2-30-0	40
AA-4-5	Truck boxes - cast iron	50-in. Niles boring mill	40	5 dc	Poor	1	Roughing	Rex AA	36	.035	2- 0-0	2	Firthite	65	.020	1-30-0	20
							Finishing	Rex AA	24	.281	0-30-0	2	Firthite	81	.030	0-30-0	20
AA-4-6	Valve chamber bushings - Cast iron	50-in. Niles boring mill	40	5 dc	Poor	1	Roughing	Rex AA	28	.035	5-30-0	1	Firthite	63	.020	3-45-0	10
							Finishing	Rex AA	21	.312	1-30-0	1	Firthite	63	.125	1-15-0	10
AO-3-1	Main and side rod bushings-Bronze	24-in. Gisholt vertical	5	Belt	Good	1	Roughing	Carbon	120	.062	0-50-0	4	Carboloy	350	.062	0-25-0	60
						2	Finishing	Carbon	120	.062	0-20-0	6	Carboloy	400	.062	0-20-0	60
AO-3-2	Piston rod - steel	24-in. x 11-ft. engine lathe	8	15	Good	1	Roughing	High speed	80	.125	4-0-0	1	Kennametal	210	.060	3-0-0	3
							Finishing	High Speed	80	.062	2-0-0	2	Kennametal	350	.030	1-0-0	5
AO-3-3	Wheels - rolled steel heat treated	58-in. Betts vertical boring mill	2	15	Good	1	Roughing	High Speed	29	.025	0-30-0	6	Kennametal	77.75	.025	0-20-0	14
							Finishing	High Speed	29	.077		14		77.75	.077		14
AO-3-4	Driving wheel tire - steel	90-in. Betts boring mill	10	40	Good	1	Roughing	High Speed	35	.180	0-20-0	1	Kennametal	180	.030	0-20-0	8
						2	Finishing	High Speed	35	.250		1	Kennametal	180	.030		8
AO-3-5	Axles and crank pins - steel	24-in. x11-ft. engine lathe	5	15	Good	1	Roughing	High Speed	60	.125	6-0-0 (axle)	1	Kennametal	260	.044	1-0-0 (axle)	3
						2	Finishing	High Speed	50	.062	3-0-0 crank pin	1	Kennametal	360	.011	1-30-0 crank pin	5
AO-3-6	Piston valve bull ring - Hunt-Spiller iron	8-in. Libby turret lathe	15	20	Fair	1	Roughing	High Speed	45	.068	1-0-0	3	Stellite J	65	.068	0-45-0	12
						2	Finishing	High Speed	45	.025	0-30-0	3	Stellite J	65	.025	0-15-0	24
AH-5-1	10-in. to 12-in. diameter side rod bushing - bronze	36-in. Bullard vertical turret lathe	1	20ac	Good	1	Roughing	18-4-1 High Speed	120	.062	0-35-0	3	Kennametal	325	.062	0-20-0	75
						2	Finishing		120	.062	0-25-0	3	Kennametal	325	.062	0-15-0	75
AB-1-1	Rod bushing - bronze	24-in. Bullard vertical turret lathe	4	15 dc	Good	1	Semi-finish (Bore and turn at same time)	Air chuck used			metal moulded castings		High Speed	254	.027	0-21-0	30
AB-1-2	Driving box - steel	Ingersoll duplex milling	4	7½ dc	Good	1	Mill shoe and wedge faces						High Speed steel milling cutters	40		0-42-0	50
AB-1-3	1⅛-in. x 14-in. Taper bolts - engine bolt iron	3-in. Jones & Lamson, 8A saddle type turret lathe	1	10 ac	Good	1	Point end of bolt	No air chuck used					Rex AAA	100		0-0-15	1,000
						2	Turn taper						Rex AAA	100	.033	0-4-0	150
AB-1-4	Driving box - steel	48-in. Bullard box borer	17	30 ac	Fair	1	Bore and face						High Speed	150	.068	0-40-0	15
AB-1-5	Crosshead shoe - Hunt-Spiller iron	24-in. x 8-ft. Ingersoll bed type	4	15 ac	Good	1	Mill guide surface						High Speed steel milling cutters	77		0-17-0	65
BJ-6-1	Driving axle 0.40 carbon steel	Monarch 26-in. x 9-ft. engine lathe	4	25 ac	Good	1	Roughing	High speed	50	.062	3-0-0	3 grinds per axle	Y-13 Stellite	120	.062	1-30-0	1
						2	Finishing	High speed	50	.062	6-0-0	3 grinds per axle	Stellite Y-13	120	.062	3-30-0	1
BJ-6-2	Tapered engine bolts S.A.E 3140 steel 1-3/8-in. x 12-in. bolts	Jones and Lamson 3-in. flat turret lathe	2	10 ac	Good	1	Turning taper	High speed	60	.031	0-6-0	35	Stellite Y-13	120	.031	0-3-0	100
BJ-6-3	Crosshead shoe - gun iron	Ingersoll 36-in. x 144-in. slab miller	15	25 ac	Fair	1	Milling crosshead fit	High speed	60	1.75	0-7-0	50	Rex 18-8	60	2.25	0-5-30	100
BJ-6-4	Piston head - gun iron	36-in. Bullard vertical turret lathe	18	15 ac	Fair	1	Boring and turning ring grooves and facing	High speed	60	.062	3-12-0	1	Stellite Y-13	120	.062	1-48-0	2
BJ-6-5	Rolled steel wheels - 0.65 to 0.80 carbon; rim-toughened	Sellers 48-in. car wheel lathe	13	50 ac	Fair	1	Turning contour	High speed	28	.375	0-30-0	3 to 4	Rex 95	28	.375	0-30-0	6 to 8
BJ-6-6	Rolled steel wheels; 0.70 to 0.80 carbon	Niles 48-in. car wheel borer	14	25 ac	Fair	1	Rough boring	High speed	72	.062	0-24-0	5	Rex 95	72	.062	0-24-0	12
						2	Finish boring	High speed	72	.062	0-24-0	5 to 6	Rex 95	72	.062	0-24-0	16

new tools and the purposes for which they are now being used.

This report deals with the uses that are actually being made of these newer tool steels and is not in any sense a recommendation with respect to potential uses for them.

The committee sent questionnaires to members of the association on 23 railroads in the United States requesting data on the performance of modern tool steels as compared with those formerly used on the same operation under identical conditions as to material and facilities. Replies were received from seven railroads. The tabulation appears in Table III. [Tables I and II showed the forms used and an analysis of the jobs on which the railroads have reported that these modern cutting steels are being used. They are not included in this abstract.—EDITOR.]

A study of Table III will indicate the extent to which a limited number of railroads are using modern tool steel, the jobs on which they are being used and, in specific cases, the comparative results obtained by the use thereof. The committee drew attention to the fact that because of the limited scope of information obtained this report must, of necessity, serve primarily as an indicator of the use of modern tool steels for locomotive parts machining operations.

Because of this fact, the data are presented in detail so that those interested in this subject may see the character of the information which forms that part of this report and draw for themselves such conclusions as may be possible from the available information.

The committee suggested that this subject is of sufficient importance to warrant a continuance of this study with the object of obtaining machine operation data sufficiently comprehensive in scope that those concerned in work of this character may be able to determine from reliable data: (1) the type of locomotive parts machining operations which can more efficiently or economically be performed with the aid of modern tool steels; (2) the extent to which these tool steels can be used on the older machine tools and the performance that may be expected under such conditions; (3) to what extent the use of modern tool steel on modern machine tool equipment will contribute to the justification for replacing a large part of the obsolete machine tool equipment now in railroad shops.

Under the present priority control of tool steels such as those containing tungsten it will probably be necessary to make a very careful study of the machining jobs involved in locomotive work with the idea of using the high-production types of tool steels on that class of work where they are most needed and can best be justified.

The report was signed by W. W. Brown, shop supervisor, B. & M.; E. A. Greame, tool foreman, D. L. & W.; W Hurst, supervisor shop machinery and tools, N. Y. N. H. & H.; F. Perkins, shop superintendent, G. T. W.; L. H. Scheifele, engineer of tests, Reading; J. I. Stewart, supervisor shop machinery, N. Y. C. and H. C. Wilcox, associate editor, *Railway Mechanical Engineer.*

Discussion

The limited discussion of this report was confined to the question as to how the railroads could get high speed and carbide tools during this emergency. Two members reported that, so far, they had had no great difficulty but suggested that shop supervisors responsible for this work should make immediate studies to determine what types of tool steels offer the best production as substitutes.

Report on Lubrication

Maintenance depends largely on proper lubrication, and proper lubrication depends on the condition and efficiency of the lubricating devices. Therefore, since the mechanical lubricator is one of the factors which affects locomotive maintenance, the maintenance practices embodied in this report are submitted for consideration.

All mechanical lubricators, piping, pipe fittings and detailed parts are to be railroad standard in size, material and design for the locomotive to which they are applied and are to be applied and maintained in accordance with the latest drawings and instructions, unless otherwise authorized by the officer in charge of lubrication.

Oil Pipes and Fittings:—Properly anneal and blow out thoroughly all oil pipes before applying. Oil pipes leading to stokers, air pumps, and feedwater heaters are to be applied as far as possible under the jacket and are to be properly clamped. Cover all oil pipes not under jacket with approved covering. It is recommended that dividers not be used on steam operated units.

Heater Pipes:—Heater drain line to discharge between frames with end visible from outside so observation can be made as to whether or not the pipe is open. Cover all exposed heater pipes with approved covering. The arrangement of heater pipes, heater line connection and use and size of chokes in line are to be in accordance with special instructions of the officer in charge of lubrication. Desirable temperature of oil in lubricator is approximately 125 deg. F. For efficient operation of lubricator, it is important that the maximum temperature of the oil does not exceed 150 deg. F.

Terminal Checks:—Apply in rigid upright position whenever possible.

Method of Piping Lubricators:—(Several diagrams were included in the report showing how various types of lubricators should be connected.—EDITOR.)

The efficiency of units should not be less than that shown in Table I.

Table I — Desired Efficiencies of Mechanical Lubricators

	Ratio Drivers to Ratchet*				
	Freight		Passenger		
	23 to 1 or less	More than 23 to 1	23 to 1 or less	More than 23 to 1	Yard
Valves, per cent	80	100	60	100	80
Cylinders, per cent	80	100	60	100	80
Feedwater pumps, per cent	70	80	60	80	60
Stoker, per cent	70	80	50	70	60
Air pump, per cent	60	70	50	70	80
Guides, per cent	60	70	50	70	50
Engine trucks, per cent	40	60	40	50	40
Boiler bearings, per cent	40	60	40	50	40
Trailer truck, per cent	40	60	40	50	40
Drifting valve, per cent	40	40	40	40	40
Receiver pipes, per cent	60	60	..	..	60
Intercepting valve, per cent	40	40	..	..	40
Other miscellaneous units, per cent	40	40	40	40	40

* Ratio referred to in the above table means complete revolutions of drivers to one of the ratchets at full cut-off for yard engines, 45 per cent cut-off for freight engines and 25 per cent cut-off for passenger engines.

Ratchet Levers:—Avoid, wherever possible, any offset in lubricator ratchet lever.

Air Pump Auxiliary Lubricator:—Where automatic or similar type lubricator is part of standard equipment for lubricating air pumps, it is to be applied by inserting a pipe tee in air pump steam line close to and ahead of pump governor (between turret and governor) and attaching lubricator in an upright position.

Setting of Lubricators

Setting Schedule:—The adjustment of individual feeds is to be the same for all locomotives in a class and in accordance with schedule furnished by the officer in charge of lubrication.

At maintaining points it is desirable to have an employee designated to set all lubricators and maintain a record of date set and the setting. After feeds are set to deliver the required amount of oil, fasten the lid securely, sealing where possible. Under no circumstance is this seal to be broken, unless trouble with lubricator or amount of oil delivered is reported or found on inspection.

Inspection

Daily Inspection:—Inspect lubricators at the end of each trip. Open drain valve at bottom of lubricator and allow all water to drain out before refilling with oil. Report to foreman immediately any water found in lubricator. Make sure all bolts

and nuts through driving mechanism are tight and cotter pins (where specified) are in place. See that all pipe joints and clamps are tight. Excessive lateral movement in valve motion is to be watched, as this has the tendency to put undue strain on lubricator lever and its connections. Report and correct all defects before engine is again dispatched.

Refilling:—Do not open cover for refilling; always use filling plug or cap. Do not use reclaimed oil from hydrostatic lubricators. Use clean oil, drawn in clean receptacle and kept clean until used. Before removing filling plug or opening cap, clean around the opening with steam or air; steam preferably, to prevent cinders and foreign matter getting in lubricator. Do not fill lubricator higher than "full" mark on gauge glass or measuring stick. This is done in order to provide space for expansion when heater is used and to prevent overflowing through the cover, causing waste of oil. It is advisable to warm the oil before pouring it into the lubricator.

Protecting Covers:—When locomotives are being washed or cleaned, canvas covers should be used to slip down on lubricator during the washing or cleaning period, to prevent water from getting into the lubricator.

Thirty-Day Inspection:—(Automatic or similar type lubricator.)

Automatic or similar type air pump lubricator, where applied, must be removed, thoroughly cleaned and inspected, to be sure that all parts are open and that choke is not stopped up. If the lubricator is not working properly, replace with one in good condition and send it to general repair point.

Six-Month Inspection:—Cleanse outside of lubricator with steam before opening, break seal (if sealed) and drain all oil from lubricator. If seal is broken at time of inspection, this should be reported to foreman in charge who will report same to the master mechanic, and all settings of adjusting screws checked and corrected.

[Note: The report included detailed suggestions for the inspection of specific makes of lubricators. This same method of treatment was followed with respect to maintenance practices for different makes of lubricators. This abstract includes only the general suggestions which apply to all types.—Editor.]

Maintenance

The only maintenance necessary at any outlying or non-maintenance point is to fill lubricators properly and maintain pipe joints, connections and pipe clamps so as to prevent leakage. Replace all inoperative terminal checks with serviceable checks and send check removed to a maintenance or general repair point for inspection and repair.

The maintenance necessary other than that required at periodical inspection periods is when improper lubrication of locomotive or accessories or leaks or other defects are found or reported, necessary repairs are to be made.

When locomotive or accessories are not being properly lubricated and all leaky pipe joints and connections have been corrected and settings properly checked, disconnect oil pipes; open pumping units to full stroke and check unit efficiencies by hand cranking at the rate of 4 revolutions of the ratchet per minute on yard and freight engines and 14 on passenger engines. Use a one-ounce measure for measuring oil delivered.

If pumping unit fails to deliver the required minimum amount of oil for the part to be serviced, remove lubricator and make general inspection. It is preferable that this general inspection be made at a general repair point where pumping units can be accurately tested on test rack and all necessary repairs be made to the mechanism. The removed lubricator can be replaced with another if available.

Where the general repair point is not equipped with rack for testing lubricators, the lubricator should be disassembled and given general repairs and the efficiency of each individual unit should be determined by the hand crank test.

No pumping unit is to be changed from one position to another, or new or secondhand unit applied, without being tested on the rack or by hand cranking before applying the lubricator to a locomotive.

Testing Terminal Check for Leaks:—To test for leaks, connect gage to plug or cap and hand crank lubricator until gage shows pressure at which check operates. If from this pressure a leakage of more than 10 lb. occurs in five minutes, remove piping between check and lubricator and apply gage to check to determine if leak is in pipe or pumping unit. If gage test is not available, disconnect feed line to terminal check, block engine, and give engine steam. If steam exhausts through oil intake connection, the terminal check is leaking and it should be repaired before reapplying.

Another method of detecting leaky terminal check, is if oil pipes are hot for a distance of two feet from terminal check; if so remove and repair terminal check. If it is found needle valve does not seat properly, renew needle valve and seat.

Remove dirty terminal checks, disassemble, thoroughly clean, make necessary repairs and renewals, retest check and reapply to locomotive.

Oil for testing terminal checks should be 300 seconds viscosity at 100 degrees F., using a straight engine oil with no other mixture.

In cleaning and repairing lubricator never use waste as it leaves lint which may collect about lubricator screens and pumping units which may shut off oil feeds. Wash all parts with a clean cleaning solution, preferably oil, and blow dry.

Dividers, Double Pumping Units:—When dividers or double pumping units are used, they should not be used to service parts operated by steam or in connection with high pressure terminal checks. However, the use of double pumping units for servicing parts operated by steam using high pressure checks is permissible, but not desirable when it can be avoided.

Dividers when being applied must be safely located to be protected from low temperatures, as far as possible, and to be able to receive convenient inspection.

Clamp well to avoid vibration and set up all pipe connections sufficiently tight to prevent leakage of pressure.

Locate so that all delivery pipes from same will be of uniform length as far as possible.

Remove and replace all dividers that are defective or inoperative, returning the defective or inoperative dividers to the respective manufacturer for necessary adjustments or repairs, or to a repair point that can properly do this kind of work.

Dividers should be tested to determine proper distribution, the

Table II—Pumping Unit Efficiencies in Relation to Delivery

Total oil delivered, CC	Total oil delivered, Drops	Pumping unit efficiency, per cent
12	90	40
12½	93	41
13	97	43
13½	101	45
14	105	46
14½	109	48
15	112	50
15½	116	51
16	120	53
16½	124	55
17	127	56
17½	131	58
18	135	60
18½	138	61
19	142	63
19½	147	65
20	150	66
20½	154	68
21	157	70
21½	161	71
22	165	73
22½	168	75
23	172	76
23½	176	78
24	180	80
24½	184	81
25	187	83
25½	191	85
26	195	86
26½	199	88
27	202	90
27½	206	91
28	210	93
28½	214	95
29	217	96
29½	221	98
30	225	100

Lubricator, Make and Type	Revolutions
Detroit, Model B	67
Detroit, Model A	52
Nathan, all types	80
King, all models	73
Chicago, all models	23
Edna (⅜-in. plunger)	66

same as for pumping units and when found not to distribute within 10 per cent of proper amount, should be returned to manufacturer or proper repair point for necessary adjustments or repairs. Dividers are not recommended for use with high pressure checks or steam operated units.

Special Reports:—Special report should be made on regular forms showing repairs made, efficiency of units when tested changes made, and efficiency after change to each unit; one copy to be sent to master mechanic of division to whom engine is assigned, one copy to the officer in charge of this work and one copy to be retained when lubricator is repaired and tested.

The information called for on this form should be carefully compiled and an accurate record kept of the performance of the lubricator. All lubricators receiving their first general repairs and test under this plan will have a number stenciled on top of the lubricator, showing the initials of the point and date where repairs and test were made. The form referred to should be mimeographed or printed, and handled as outlined above.

Testing Pumping Units

It is preferable that the efficiency of lubricator pumping units be determined by tests made on a test rack, specially designed for this purpose. Where test rack is not available, the efficiency of the pumping units is to be determined by hand cranking.

Test Rack Procedure

Completely submerge pumping units in light engine oil of 300 viscosity at 100 deg. F. Do not use any mixture of any other kind of oil, as this will destroy the value of relative efficiencies. Change oil with every third lubricator, using that removed for oiling shop machinery, etc.

Make all tests with pumping units in wide open position except Edna, which are set to ¼-in. stroke.

First: Test units at the slow speed test of 4 r.p.m. of the ratchet. This test to be designated by the letter "S".

Second: Test units at the first speed test of 14 r.p.m. of the ratchet. This test to be designated by the letter "F".

In each test the ratchet should be turned for the complete number of revolutions shown in the tabulation shown in Table II, opposite the make of lubricator tested and the total oil delivered by each unit in these numbers of revolutions measured, preferably in a 100 cc graduated glass.

Hand Crank Test

If a test rack is not available at the point, where in accordance with these instructions, the lubricator is to be given general repairs, (general repair point or maintaining point) the efficiency of each pumping unit is to be determined at the time the lubricator receives general repairs, by hand cranking lubricator and following the same procedure otherwise as for test rack test.

At times other than general repairs, when necessary to apply new or secondhand pumping units or when on account of parts not being properly lubricated pumping unit efficiencies are to be checked in accordance with instructions the lubricator being hand cranked in place on the locomotive and the pumping unit efficiency determined as on rack test.

Great care must be exercised in hand cranking to see that the lubricator is cranked at the specified speeds of 4 and 14 r.p.m.

The report was signed by J. R. Brooks (chairman), supervisor, lubrication and supplies, C. & O., Richmond, Va.; W. R. Sugg, superintendent fuel conservation, Mo. Pac., St. Louis, Mo.; D. C. Davis, lubrication engineer, A. T. & S. F., Topeka, Kans.; L. N. Griffith, lubrication engineer, So. Pac., San Francisco, Calif. and J. W. Hergenhan, assistant engineer, test department, N. Y. C., New York.

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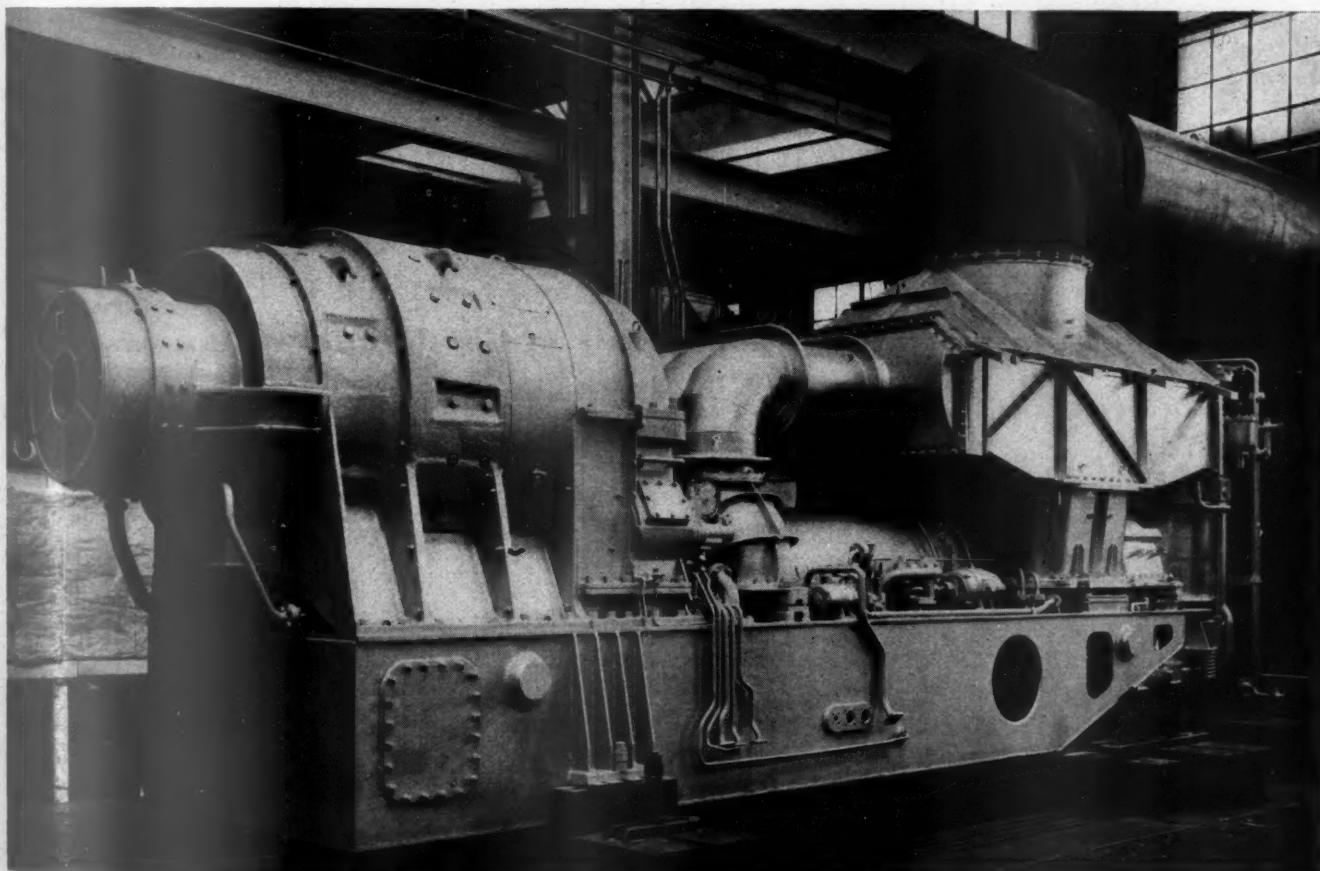


The power equipment for a gas-turbine locomotive built for the Swiss Federal Railway by Brown, Boveri & Co., Ltd.

The main generator (left) is rated at 2,200 hp.; the auxiliary generator (in the same housing) at 200 hp.; the exciter is at the extreme left—The vertical cylinder at the extreme right is the combustion chamber adjoining which are the heat exchangers (above) and the gas turbine (below)—Adjoining and directly connected to the gas turbine is the air compressor and above it the air inlets to the heat exchangers—The generators are gear driven from the compressor shaft—The complete locomotive was subjected to road tests during the summer.

Efficient Utilization
Urged at M.

C. W. Buffington,
President

Latest method of repairing flues, importance of treating boiler feed water, straight versus tapered radical staybolts and application of iron and steel alloy rivets were among the subjects discussed during the convention

THE twenty-eighth annual meeting of the Master Boiler Makers' Association, held at the Hotel Sherman, Chicago, on September 23 and 24, was attended by nearly 300 members and guests. The meeting was opened by an address by President C. W. Buffington, general master boiler maker, C. & O. Another address was made by C. B. Hitch, superintendent of motive power, C. & O.

Five committee reports and three individual papers were included in the program of the meeting. The papers were read by E. M. Grime, engineer of water service, N. P., on Recent Trends in Boiler Water Treatment; by Ray McBrian, engineer of standards and research, D. & R. G. W., on Steel for Firebox Boilers; and by F. P. Houston, International Nickel Company, on Staybolts.

Importance and Responsibility of Good Supervision

By C. B. Hitch

Superintendent of Motive Power, Chesapeake & Ohio

Mr. Hitch said that never was there a time when the importance and responsibility of good supervision in the boiler department should be given greater consideration. "You are aware," he continued, "of the increased difficulty and delay in obtaining various materials, particularly boiler steel. This situation is likely to continue for some time and probably will become more difficult before it improves. The conservation of material is, therefore, of the utmost importance.

"This situation throws a heavy responsibility on the supervision of the boiler department along with all other departments on our railroads, since we must be prepared to handle increased business with a decreased supply of new materials available for repairs and new construction. Therefore, we must improve our efficiency in the use of materials.

"It may be necessary, in many cases, to resort to patching where, under more favorable conditions, new construction would otherwise be used. To determine the extent to which patching should be done will require a high degree of skill and judgment on the part of the boiler shop supervision, since strength and safety must not be sacrificed. There will be a tendency to lower the quality of new materials produced, including boiler steel, and such a condition will require extra care in the inspection and selection of material if strength and safety are to be maintained.

"The conservation of material will require a high degree of skill and workmanship on the part of boiler shop labor. This applies particularly to such operations as laying out, chipping, drilling, flanging, etc., in which considerable material can be spoiled or excess used if proper care and judgment is not exercised. It is also important that the tools used in performing these various operations be maintained in good condition and in proper adjustment.

"You are all aware of the increased demands for motive power and the length of time now required to build new locomotives. This makes it necessary that present locomotives be available for service the greatest possible time, which means that time out of service for shopping and running repairs must be reduced to a minimum.

"The problem is complicated by the demand for skilled labor in the defense industries, which has decreased the supply available to the railroads. This in the face of the fact that the amount of skilled labor required by the railroads has increased due to the increase in traffic brought on by the defense program. The

# of Available Materials
B. M. A. Meeting

result has been the calling back of large numbers of men who have been on furlough for some time, and in some instances, the employment of new men who are not familiar with railroad work, and who must be broken in and trained before they can become efficient workmen. It is the duty of the supervising officers to provide the necessary training. It is impossible for the supervising officer to give each man individual attention for any considerable length of time, however, by providing adequate supervision, the situation can, if proper judgment and foresight is used, be successfully handled.

"For instance, the particular qualifications of each man can be determined and he should be assigned to the work for which he is best suited. Those having little or no experience should be given jobs requiring the least skill, while those better qualified can be given more exacting work. Also, inexperienced men should be assigned to work with more experienced men whenever possible and advanced to more difficult work as their skill develops, or assigned a certain job for which they show particular aptitude.

"This system has been tried out in other industries and proved to have the advantage of allowing a skilled force to be built up rapidly in case of emergency. However, if carried too far, it has the disadvantage of developing a large number of so-called specialists who would not be fit for general boiler work and who could not be used to advantage if there should be an appreciable falling off in the amount of work to be handled. It is up to supervision to determine just how far it should be carried. This advantage can be reduced considerably by maintaining a full quota of apprentices and by seeing that they receive proper general training.

The increased demand for available locomotives calls for increased shop output. It is up to supervision to see that the necessary work is performed, and that the output is not increased at the expense of good workmanship. It is far better to experience some delay in the shop than to risk accidents and failures on the road. The situation imposes considerable responsibility on the boiler inspectors. They are charged with the duty of reporting work necessary to maintain the boilers in a safe and suitable condition for service, and that all repair work is properly done. Under present conditions they should be particularly careful to see that no unnecessary work is called for. This will require the very best of judgment on their part.

"If the work is scheduled and the officers in charge of the main shops are informed a sufficient length of time in advance as to the condition of the boiler on each locomotive, together with the work that will be required at the next shopping of the locomotive, they can and will have on hand the necessary materials and labor to handle the work promptly and efficiently."

M. C. France,
Vice-President and
Chairman Executive Board

A. F. Stiglmeier,
Sec.-Treas.

Application and Maintenance of Flues and Tubes

The first part of this report went into the details of cleaning, cutting and safe-ending flues and tubes and described some of the recently developed equipment for doing this work in the flue shop. This abstract is confined to that part of the report dealing with the application and maintenance of flues and tube and the problem of cracks in flues.

Application and Maintenance of Flues and Tubes

On new flue sheets care is taken to drill a smooth hole which is chamfered on both sides to 1/16-in. radius, all flue holes having 1-in. guide hole punched first. 2-in. and 2 1/4-in. tube holes are drilled the same size as the outside diameter of tube in back flue sheet and 1/16-in. over the outside diameter of tube in front flue sheet, 3 1/2 in. and larger are cut with a special two blade cutter, 3 1/2 in. flues being swedged to 3 in. outside diameter. The hole in the back flue sheet is cut 5/32-in. and hole in front flue sheet cut 3 19/32 in. 5 1/2 in. outside diameter flues are swedged to 4 1/2 in. outside diameter and hole in back flue sheet cut 4 23/32 in., in front sheet 5 19/32 in., all work being handled on a large radial drill.

On old back flue sheets, the old welding is removed if flues are welded to back sheet and flue holes chamfered with a rose-bud bit, or filed by hand with a half-round file. Flue holes found out of round are reamed.

Flues are applied with copper ferrules, expanded and beaded. Copper ferrules are 5/8 in. wide and of varying thickness to compensate for wear in flue hole. Coppers are set in sheet 1/32 in. in on fire side and rolled in place. All flues are applied with a slight drive fit; 2 in. and 2 1/4 in. tubes are set to length with a tube setter sectional expander, allowing 1/4 in. for the bead. Large flues are set and heeled over by hand. All flues and tubes are expanded in the back end with boss expander, turning expander three times in each tube or flue. After flues or tubes have been expanded on back end, front end is cut to length. Flues and tubes are then beaded in the back end. All flues and tubes are shimmed if necessary and rolled on front end. All superheater flues and 30 to 60 per cent of all small tubes are beaded on front end. After break-in fire up, superheater flues are light rolled and all flues run over with beading tool on back end and welded. Some railroads do not make a general practice of electric welding beads when flues are applied. In some districts flues run their life without requiring electric welding

of beads. In other districts beads are welded at 30,000 to 40,000 miles of service.

Cinder cutting is the heaviest maintenance item on high pressure and high capacity engines. It is necessary to renew part of a set of flues and tubes due to cinder cutting at 90,000 to 100,000 miles. This is generally in the form of a vee at the top and requires renewal of approximately 100 flues and 30 tubes.

When flue beads are electric welded, the flues are worked over; that is, expanded and beaded, sheet and beads sand blasted, and electric welded with boiler filled with warm water, starting welding in center and working both ways.

Arch Tubes

The following method should be followed as closely as possible, that there may be a standard application. Drill a guide hole in sheet or punch hole, then drill proper size hole for tube 1/32 in. larger than tube. Have the tube bent by a cold bending machine.

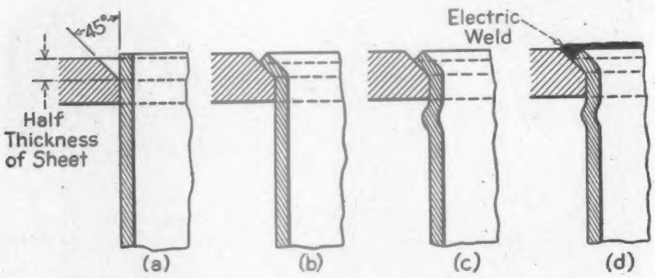


Fig. 1—Method of applying welded flues flush with sheet

Cutting the tubes off with oxy-acetylene torch is not recommended without chipping off the slag accumulation after burning. The tubes then should be properly placed in holes and held with clamps so they will not slip. Also use gage to see that they are held straight for proper set for arch brick. Then roll and bead or flare out. We recommend that the tubes extend past the sheet 1/4 in. for beading, and 3/8 in. for belling.

The use of copper ferrules where tube holes become large is good practice, but the thickness of copper should have a limit. We recommend that the radius of arch tubes be given careful consideration, as we feel that better cleaning can be done as well as taking care of the expansion and contraction. They should enter the sheets at right angle, where possible. Good results are also being obtained where the sheet at holes are built up to 3/4 in. thick.

The Cause of Flues Cracking

Cracking is caused by the expansion and contraction of flues allowing sediment to enter the space between the flue and the copper, causing small leaks through welds. These small leaks add to the caustic contents of the scale until the flue is cracked. By applying an antidote which is immune to caustic, it is hoped that the beads will not crack.

Before this was found two locomotives, one a large Pacific and the other a large Mikado, carrying steam pressures of 215 lb. and 225 lb. respectively, had flues set without the use of copper ferrules. The back flue sheet was countersunk 1/8 in. deep, flues worked in hole the usual way and flues beaded back in center line of hole, after which flue bead was welded to sheet. This was done with the thought of keeping the flue bead as cool as possible and thus avoid flue beads burning and breaking.

These locomotives are now going into their third year, having made more than 100,000 miles each, with no trouble from burned flue beads or cracking of same. This proves that if the flue bead is kept cool, it will not crack.

The fire cracking of flues has long been the source of trouble and expense to the railroads. There is a method used in applying flues with success, that is, countersinking the sheet. Flues are flared over in the counter-sink and welded, after they have been worked. This method is shown in Fig. 1.

Some roads safe end their flues with a heavy gage safe end, but it does not correct the trouble with fire cracking, leaking from welds breaking loose and cinder cutting.

In February, 1936, we devised a method of applying a sleeve to a tube, an application of which was made to a Pacific type passenger locomotive at the crown sheet, where the circulating tube enters. The original tubes are still in service, having almost five years service in heavy passenger duty. These tubes have never leaked, nor was it necessary to do any work on them, other than to clean them at monthly inspection periods. Later on this same method was used to apply arch tubes, and still later, flues were applied using this same method. There are some flues that have been in service three years, without a sign of a leak, and in no case has there been any trouble experienced since this method was used. This method is shown in Fig. 2.

In the application of a flue, using this method, the copper ferrule is eliminated and the flue is swedged straight back to receive the sleeve, the sleeve being slightly smaller than the hole in the back flue sheet. The sleeve is welded to the flue on the water side, and when applied is left flush with the back of the flue sheet. The flue sheet being countersunk slightly. The sleeve is then welded to the sheet, after the flue has been rolled just tight in the sheet. The flue which projects over the sleeve can then be beaded, and it is optional whether the beading is welded or not.

This method has been used successfully on the circulating tubes of semi-water tube fireboxes since February, 1936 and is now used exclusively on one railroad with this type of firebox. As a matter of fact, it is a standard application and these tubes are connected to the crown sheet and side sheets with this arrangement. This method is now being used in the application of flues. It is particularly adaptable and beneficial where the tubes are subject to cinder cutting, as two thicknesses of metal, will, of course, stand twice the amount of cinder cutting.

In the application of flues, the welding of the sleeves to the flues is now being done by acetylene. The first arrangement called for electric welding at this point, but both methods are equally good. The thought was that there may be the possibility of electric weld penetrating too deep into the flue, or perhaps burn completely through, which of course, would destroy the end, so as a matter of precaution, it is recommended that the flues be welded to the sleeves by acetylene. The application of the flues, after the sleeves have been welded on the water side, should be as follows: The flue hole should be countersunk at one half the depth, at 45 deg. and after the flue is applied to the hole, the end of the sleeve should be flush with the outside of the back of the flue sheet, and rolled just tight in the sheet. The sleeve is then electrically welded to the flue sheet at the countersink, all the way around. After the sleeve has been welded to the sheet, the weld is smoothed flush with a light bobbing or chip off the weld flush with the sheet. The end of the flue is then beaded, and it is optional as to whether the beading is to be welded or not. It is not recommended that the beading be welded, as this may defeat the expansion and contraction which occurs at this point.

In October, 1940, a complete set of flues were applied by this method. These were located at critical points where cinder cutting is the heaviest, and temperatures are the highest. Inspection was made the first of this month, and it was noticed that the flues applied by the standard method were leaking and cracking; while

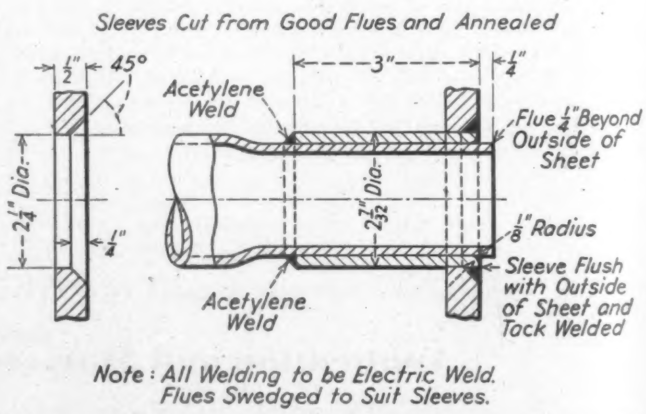


Fig. 2—Left: Hole in back tube sheet—Right: Flues applied with welded sleeves and tack welded to back tube sheet

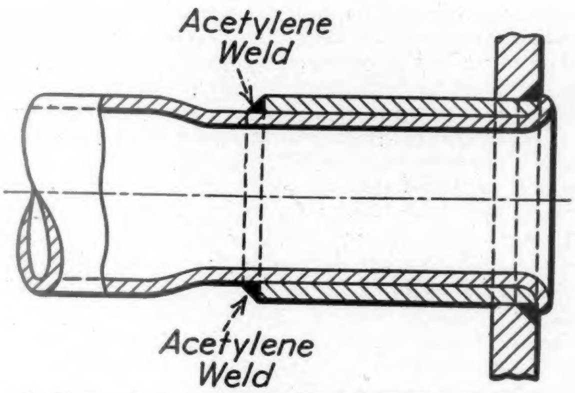


Fig. 3—Flues and sleeves rolled tight in back tube sheet, sleeves welded complete and bead applied to flues

the flues applied with the sleeve looked just the same as they were the day they were applied.

The report was signed by Frank A. Longo (chairman), general boiler foreman, S. P.; J. M. Stoner (vice-chairman), supervisor of boilers, N. Y. C.; H. A. Bell, general boiler inspector, C. B. & Q.; S. P. Mahanes, district boiler inspector, C. & O.; H. E. May, shop engineer, I. C.; G. E. Burkholtz, general boiler inspector, St. L.-S. F.; J. J. Desmond, boiler foreman, Washington Terminal Co.; W. Freischleg, boiler foreman, Wabash; T. H. Moore, general boiler inspector, W. M., and E. H. Gilley, general boiler foreman, Grand Trunk.

Discussion

There was considerable discussion on the problem of cinder cutting. Some roads tried leaving out copper ferrules resulting in increased cutting. When one road did this the mileage between flue renewal dropped to 90,000. The ferrules were restored and the mileage increased to 225,000. Another road which prossered, beaded and welded flues, obtained from 342,000 to 350,000 flue mileage. This same road obtained 577,628 flue miles on a Hudson type locomotive. It was generally agreed that no positive cure has been found for cinder cutting.

Straight Vs. Tapered Radial Staybolts

Over a period of 27 years, committees of this Association have made tests to determine the relative holding power of various types of crown bolts. The tests conducted in 1910 indicated that button-head radials showed a decrease of 56.4 per cent in holding power when heated to 860 deg. F. as compared to 70 deg. F. Tapered head radials showed a decrease of 51.4 per cent when heated to 820 deg. F. The button-head radials failed at the head and pulled through the sheet whereas the tapered-head radials sheared off the head and stripped the threads on the bolt and in the sheet. Similar tests on straight radials indicated a decrease in holding power of 60.8 per cent.

Tests were conducted again in 1921 with the following results:

Test No.	Condition of pull	Where broken	Kind of head	Lb. pull	Remarks, in.
1	Cold	Head pulled off	Button-head with 1/8 head drilled off	23,750	Plate dished 1/4
15	Cold	Bolt broke 3 inches from head	Full button-head	29,510	Plate dished 1/8
4	Cold	Head pulled through sheet	Hammered head with taper 1½ inches in 12 inches	19,400	Plate dished 5/8
14	Cherry red	Head pulled off	Full button-head	7,100	Plate dished 5/8
7	Cherry red	Head pulled off	Button head with 1/8 head drilled off	7,730	Plate dished 5/8
11	Cherry red	Head pulled through sheet	Hammered head with taper 1½ inches in 12 inches	2,900	Plate dished 5/8

All of the above tests with the exception of those made cold, were made with the heat as near the same temperature as it was possible to get them, that is about a cherry red. It can be seen that as long as the sheet is cold the hammered head type of bolt is of ample strength and even when the sheet is cherry red it takes 2,900 lb. to force the plate from the bolt.

Test of Steel Crown Bolts

Presuming that these previous recorded tests were made with iron staybolts it was thought to be of value to this present investigation and purpose of this topic if a test could be made of steel crown bolts as a comparison with the previous tests. Through the courtesy of the management of a railroad using all steel staybolts this was arranged. Three types of crown bolts were tested. Straight threaded bolts with hammered heads, tapered threaded bolts (1½ inch in 12 inch) with hammered heads, and a button or panhead type of bolt. These were applied to section of 5/8-inch. firebox steel plate. One of each type of bolt was pulled at room temperature, and one of each type was pulled with plate and bolt heated to a dull red, about 750 to 800 deg. F.

These tests were made on a Riehle testing machine with the following results. All bolts made from 15/16 inch steel bar stock with ends upset in bolt machine.

Test No.	Condition of pull	Where broken	Kind of head	Lb. pull	Remarks, in.
1	Cold	Head pulled off and bolt out of sheet	Straight hammered head 1⅛ inches diameter	33,020	Plate dished 1/4
2	Cold	Head pulled off and bolt out of sheet	Hammered head with taper 1½ inches in 12 inches, diameter 1⅛ inches	33,250	Plate dished 1/4
3	Cold	Body of bolt elongated	Panhead bolt, 1⅛ inches dia., taper ½ inch in 12 inches	42,300	Plate dished 1/2
4	Dull red	Head pulled off and bolt out of sheet	Straight hammered head 1⅛ inches diameter	31,200	Plate dished 3/8
5	Dull red	Head pulled off and bolt out of sheet	Hammered head with taper ½ inch in 12 inches, diameter 1⅛ inches	34,850	Plate dished 7/8
6	Dull red	Body of bolt elongated	Panhead bolt, 1⅛ inches diameter, taper ½ inch in 12 inches	41,750	Plate dished 1/2

It will be noted that in each test of the straight threaded bolts and the tapered bolts they failed by pulling out of the sheet, whereas in both tests of the panhead bolt the head held, the point of failure was in the body of the bolt which yielded.

The behavior of the heated taper bolt was rather interesting, although both were made at the same time from the same material, it required 1,600 more pounds to pull the tapered bolt heated than it did to pull it cold.

The test however clearly indicates the superior strength of the panhead bolt over the taper and straight radials.

Committee Not Unanimous in Opinion

The majority of this committee, basing their opinion on many years of experience, recommend the adoption of the tapered hammered head as standard. However, the question in the mind of the chairman of this committee is, "Should we sacrifice a greater degree of security for ease of application and maintenance?" For

The Newly Elected Officers

***President:* Myron C. France, general boiler foreman, C. St. P., M. & O., St. Paul, Minn.; *vice-president:* Frank A. Longo, general boiler inspector, So. Pac., Red Wood City, Calif.; *secretary-treasurer:* A. F. Stiglmeier, general supervisor of boilers and welding, N. Y. C., Albany, N. Y. *Executive Committee—term expiring in 1944:* Sigurd Christopherson, supervisor of boiler inspection and maintenance, N. Y. N. H. & H., East Milton, Mass.; R. W. Barrett, chief boiler inspector, Can. Nat., Toronto, Ont.; E. H. Gilley, general boiler foreman, G. T. W., Battle Creek, Mich.**

many years the Canadian National adopted as standard the button-head type of bolt. In common with many other railroads it was decided to replace button-heads with taper headed bolts, with hammered ends on all locomotives. Thus on all new power and new firebox applications alternate sections of straight and taper crown bolts were applied. Taper 1½ inch in 12 inch. From a maintenance point of view this was very satisfactory; any leaks occurring could easily be taken care of, which admittedly is more difficult in the case of button-head application. However, experience has taught us that a greater degree of security is more essential than ease of application and maintenance. Consequently it was decided after careful consideration that as the panhead crown bolt was the design that would sustain the maximum amount of pressure, and the straight threaded hammered head bolt was the weakest, that all non-syphon locomotives passing through the shops for repairs, the crown sheets should be changed as shown in Fig. 1. The first four rows to be flexible expansion stays followed by alternate sections of panhead bolts and straight hammered head radials. These are from 10 to 14 rows wide according to the width of the firebox. Fig. 2 shows the design of the panhead crown bolt having a taper of ½ inch in 12 inch.

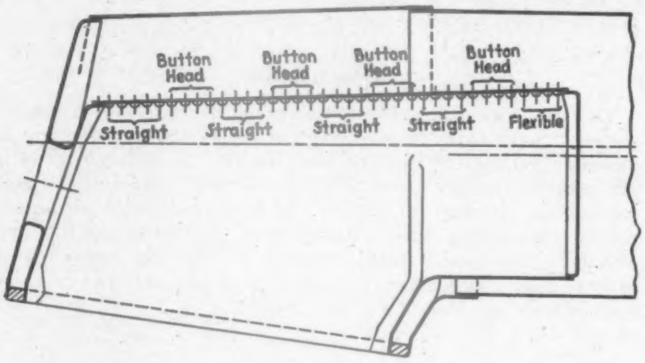
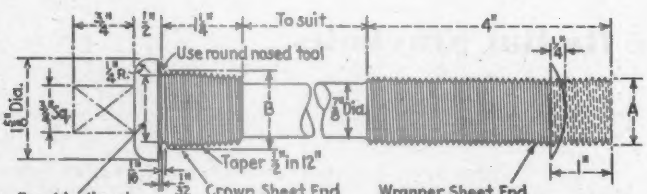
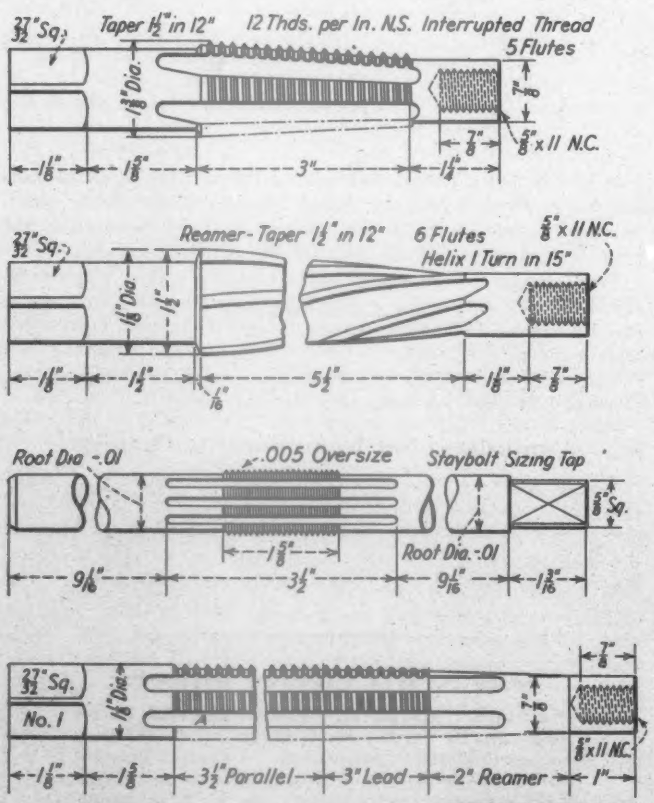


Fig. 1



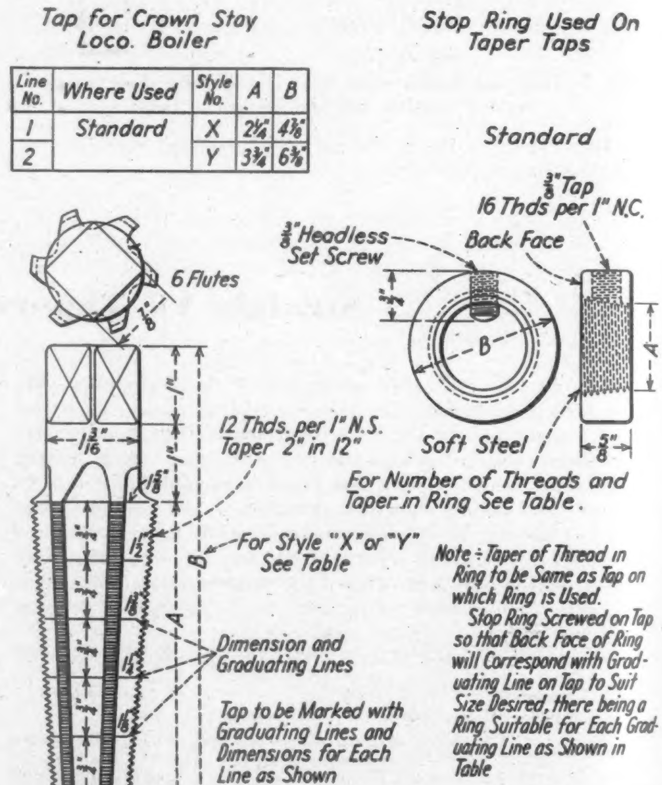
B	A	Remarks	Line No.
1 3/16"	1 1/16"	New Work	1
1 5/16" Max.	1 3/16" Max.	Renewals	2

Fig. 2



Tap No. 2	Tap No. 1	
A	A	Line No.
1 5/32"	1 1/8"	1
1 7/32"	1 3/16"	2
1 9/32"	1 1/4"	3
1 11/32"	1 5/16"	4

Fig. 3



Line No.	Where Used	Style No.	A	B
1	Standard	X	2¼"	4⅜"
2		Y	3¾"	6⅜"

Size of Tap	Line No.	Ring Fit 12 Thread Tap Taper 2" in 12" A	B
1"-1⅝"	1	1⅛"	
	2	1¼"	2½"
	3	1⅜"	
	4	1½"	

Fig. 4

For oil burning locomotives where the excess material in the head of the panhead may give trouble, it is recommended that alternate sections of minimum diameter straight threaded bolts and taper bolts at least ⅛ inch larger in diameter be used. In other words, that alternate weak and strong sections of bolts be applied.

Taper Per Foot

A survey of previous reports as to the most desirable taper for crown bolts have shown these to vary from ¾ inch to 3 inch in 12 inch. The majority, however, favoring 1½ in. in 12 inch, as being the taper most suitable for adequate staying of the crown sheet. It being claimed for this type of bolt that once they are properly applied they are there to stay for the full life of the firebox.

The following table gives the permissible tolerances for straight taps and should be adhered to at all times.

Dia. of staybolt, in.	Minimum tap dia., in.	Maximum tap. dia., in.	Tolerance allowed
15/16	.9385	.9425	.0040
1	1.0010	1.0050	.0040
1 1/16	1.0635	1.0675	.0040
1 1/8	1.1265	1.1310	.0045
1 3/16	1.1890	1.1935	.0045
1 1/4	1.2515	1.2560	.0045

For new boilers or application of new fireboxes to boilers removed from their frames where boilers can be turned it is advantageous to use long taps in some instances. In general, however, it is recommended that short parallel taps as shown in Fig. 3 be used with spindles or pilots of required lengths.

No attempt is made to synchronize the threads of the inside and outside sheets as it is found from experience that the crown sheet will adjust itself to any little variation of pitch. The use of interrupted thread taps permits greater ease in tapping.

For the application of tapered crown bolts, the taps shown in Figs. 3 and 4 are the style most favored for this work. The reamers are also shown. These can be made from used taps ground to suit.

Steel Staybolts

The use of iron for stay and crown bolts is common on this continent, whereas those who use steel bolts are in the minority. The Canadian National was the pioneer in the use of steel staybolts, having applied these exclusively to their fireboxes for the past twenty years. Objections have been raised to the use of steel, that they are hard to drive, difficult to thread, and do not upset in the holes. This has not been the experience of the above mentioned railroad. At first when the change over was introduced men riveting staybolts noticed that the bolts were somewhat harder to drive. This was soon forgotten; also it has been found advisable on the vertical threading machines to thread steel bolts with a preliminary and finishing cut to ensure a perfect threaded staybolt. Any extra cost involved in the application of steel bolts is more than amply repaid by the freedom from broken stay and crown bolts in enginehouses. Formerly in the iron staybolt days enginehouses who did not report the renewing of 200 to 300 broken staybolts per month were suspected of neglect in their staybolt examinations, today finding of broken staybolts at monthly and annual examinations is the exception rather than the rule.

The report was signed by R. W. Barrett (chairman), general boiler foreman, Can. Nat.; Wm. N. Moore (vice-chairman), general boiler foreman, P. M.; H. H. Service, general boiler inspector, A. T. & S. F.; E. E. Owens, general boiler inspector, U. P.; L. R. Haase, district boiler inspector, B. & O.; G. L. Young, boiler foreman, Reading; Mark Manley, general boiler inspector, L. & N.; L. Nicholas, general boiler foreman, C. I. & L. and James A. Guinther, boiler foreman, L. & N. E.

Discussion

The discussion centered around the experience the various railroads have had with the tapered radial staybolt. One road reported that when it adopted this type of staybolt, crownsheet leaks were eliminated and maintenance reduced to a minimum.

Chemical Treatment of Boiler Feedwater

At the present time there is general acceptance of the theory and practice of water treatment. Most of the important main line watering stations on our railroads are receiving treatment. However, there remains a large field for further improvement in the proper application of water treatment to the remaining water supply stations on the main lines and to the water stations on branch lines, etc., as will be covered more fully in this report.

Outstanding in the development of water treatment during the last decade and of particular interest to boiler makers has been the development of testing apparatus for the control of all the various phases of these operations. Test kits have been developed for rapid field analysis of the raw and treated water supplies so that it is possible to determine the amount of treatment necessary and then check to see that the final product is up to standard. Other test apparatus has been developed that makes it possible to know exactly the condition of the water in the boiler within a few minutes after its arrival in a terminal. Thus it is possible, at all times, to control and check all factors of boiler operation whether it pertains to the condition of the heating surfaces of the boiler or to the quality of steam that the boiler is capable of producing.

Savings Effected in Boiler Maintenance and in Fuel

The railroads of the United States use about 350 billion gallons of water a year only about half of which is treated for boiler feed purposes. A conservative estimate of the scale forming matter neutralized by such treatment would be approximately 262,500,000 lb. Studies made by the Water Service Committee of the A. R. E. A. indicate a saving of 13 cents per pound of scale-forming matter removed. The actual experience of railroads has indicated savings considerably in excess of this figure. However, at a 13 cent a pound figure, the potential annual saving to the railroads would be $33,125,000.

One railroad has saved, in a decade in washouts alone, 1¼ cents per mile. All committee members reported that their roads had been able, where 100 per cent treatment was used, to extend greatly the washout periods. Another reports a saving of 1.2 cents per mile in boiler makers' payroll costs, and ⅜ cents saving in fuel per mile since going from partial to 100 per cent boiler feedwater treatment. From the available data, it would indicate that when all savings made possible by complete treatment are taken into account, a road should save from 4 to 7 cents per locomotive mile.

Since the proven savings due to water treatment are so great and since there is available to the railroads a further savings of upwards of $25,000,000 per year through the extension of water treatment to the remaining untreated water supplies, we unreservedly put ourselves on record as recommending the completion of the water treatment program at the earliest moment, not only for the savings to be realized, but also to obtain greater availability of power.

Pitting and Corrosion in Boilers

With few exceptions, the problem of pitting and corrosion has been minimized. The chemicals best suited for the prevention of scale formation have also taken care of all but the worst cases of attack on metal. The water service committee of the A. R. E. A. and the feedwater treatment companies have found that by carrying the proper ratio of alkalinity, together with suitable organic treatment, pitting and corrosion can be eliminated. The reports of the membership substantiate these claims. The one report we have of pitting and corrosion comes from South America where treatment of a different type than that generally in use in the United States is being used. These difficulties are being minimized by the use of supplementary treatment.

Insofar as United States practice is concerned, adherence to present practice where complete treatment is now provided and the extension of these practices to present untreated or partially treated supplies will completely eliminate this problem as a matter of any consideration from our maintenance program.

Control of Dissolved Solids and the Most Economical Method of Blowing off Boilers

The development of a comprehensive water treatment program is a complex problem, but not necessarily a difficult one. The one thing essential to success is the understanding cooperation of all departments of the railroad concerned with these operations. The engineering, operating, and mechanical departments are all involved in the program and each contributes to the success of the operation.

Proper test equipment is essential to the success of the water treatment program. Such apparatus has been made available over a period of years due to the pioneering efforts of the large

water treatment companies. Portable test kits for every kind of test of raw, treated, or boiler water are available to the railroads, together with the services of qualified men to instruct and assist supervisors in making whatever adjustments may be required as determined by such tests.

An important part of this work is the control of the amount of dissolved solids in the boiler water of engines being handled at terminals. Test apparatus is now available which indicates the total dissolved solids in a quick, simple manner. The use of this apparatus determines the actual condition of the boiler water and the resultant figures may be used on the work report to justify continued operation of the boiler without either a water change or boiler wash if the readings show that such work is not required. Frequently it is only necessary to blow down one or two glasses of water in order to condition the boiler for another trip, thus keeping the locomotive in service.

The best types of apparatus for such terminal testing use the electrical conductivity principle. The Nalcometer furnished by the National Aluminate Corporation is of this type. Corresponding apparatus known as the Dearborn Concentrometer is furnished by the Dearborn Chemical Company.

We are further advised by the chemical companies that their research departments are continuing their studies working toward producing treatments which will permit carrying higher dissolved solids in the boiler waters. This would permit safe operation with a reduced blow-down schedule and is a worthwhile development.

The blowing of boilers is equally important. We find that most railroads control the blowing by the intermittent use of the large blow-off cocks. A great many improvements have been made in design and location of intermittent blow-down equipment, so as to take care of localized conditions of the various railroads. The use of the automatic continuous blow-off equipment has been extended during the past years, as has the electromatic system of blowing. The further use and improvements of these automatic systems of blow-down will, no doubt, be made, to the benefit of all railroads.

We have learned that all natural waters analyze differently from a chemical standpoint. Since all waters are not the same chemically, the equipment and treatments to treat these various waters, must be designed so that a uniform result is obtained. If railroads are to take full advantage of 100 per cent treatment of boiler feed waters, the railroads themselves must have this department organized and controlled so that complete cooperation will be had between all other departments.

This association is well aware of the research work that has been, and is now being done by the water treating companies and other research institutions. It would appear that our duty as railroaders, is more clearly to determine the actual saving that has and can be made, by the use of water treatment, and to see that such savings are made. Since such savings must include the study of the quality of water, type of treatment, and maintenance and operating cost figures, it would seem advisable that the A. R. E. A. Water Service Committee and the Master Boiler Makers' Association should work on the project of developing suitable figures covering the actual savings that can be made by properly treating all types of boiler feedwaters. We have been advised by some members, located in the South and East, that they have been unable to justify expenditures for treatment on low-hardness, high-silica-content waters by the use of the A. R. E. A.'s 13-cent figures, whereas, it is known that the maintenance cost, in actual practice, far exceeds the cost of proper water treatment.

The report was signed by Carl A. Harper (chairman), general boiler inspector, N. Y. C. (Big Four); I. N. Mosley (vice-chairman), master boiler maker, N. & W.; S. E. Fegan, district boiler inspector, Can. Nat.; F. H. Maurer, boiler foreman, B. & A.; E. Crapper, chief boiler inspector, Buenos Aires Great Southern (Argentina); R. L. Guanero, general boiler foreman, D. & R. G. W.; A. P. Roberson, district boiler inspector, Great Northern, and L. J. Johnson, Jr., boiler foreman, F. E. C.

Discussion

Two prepared discussions and an illustrated talk by W. C. Schrader, Bureau of Mines, Washington, D. C., followed the presentation of this topic. Mr. Schrader stated that three factors combine to produce inter-crystalline cracks in a boiler. (1) leakage that allows concentration of the boiler water; (2) high stress in the boiler metal arising either from cold work or applied stress; and (3) chemical action of the concentrated boiler water on the stressed steel. He then presented slides which showed the design of an embrittlement detector that can be attached to the side of the locomotive boiler. This device was described in an article on page 262 of the July, 1940, issue of *Railway Mechanical Engineer*.

He then showed test results using waste sulfite liquor in the feed water of both carbon steel and high alloy steel locomotive boilers. The use of this chemical slightly reduced the cracks in the boiler steel. Sodium nitrate was then used in similar locomotive boilers with the result that no cracks appeared in the boilers under tests. These tests, he said, indicated that they have gone far in finding the solution to caustic embrittlement or intercrystalline cracking.

Shop Kinks and New Ways of Doing Things in the Boiler Shop

This report was a collection of notes and drawings on methods of performing boiler operations found satisfactory by members of the association. From a group of 17 ideas illustrated in the report a selection, shown on these two pages, was made. Fig. 1 shows a method of patching a syphon-equipped boiler so that about nine welds may be eliminated in a troublesome zone. Fig. 2 shows an improved type of cylinder head casing fabricated by the use of welding. Fig. 3 is a method for providing the air pump clearance at the smokebox front. Welding is again used in the manhole cover hinge in Fig. 4. When it becomes necessary to renew an outside throat sheet without removing the boiler from the frames the manner in which it may be accomplished is seen in Fig. 5. Fig. 6 shows an arrangement for tender tank splash plates which was found to be without cracked sheets or loose rivets after eight years service. Experience indicates that the sheets should be flanged not less than 2 in. or more than 3 in. for best results. Fig. 7 is a home-made holder-on of the yoke type by means of which work can be done on shell courses without removing the dry pipe or on outside throat sheets without removing the combustion chamber. These are only two of its many uses. A strong and solid staging in a safety requirement in any shop and the one shown in Fig. 8 meets rigid requirements. Some of the other shop kinks not included here are flanging block for syphon diaphragm; heavy gage nickel-content flue safe end; rotary flue bead remover and a method of locating crown sheet.

Notes on Boiler Work

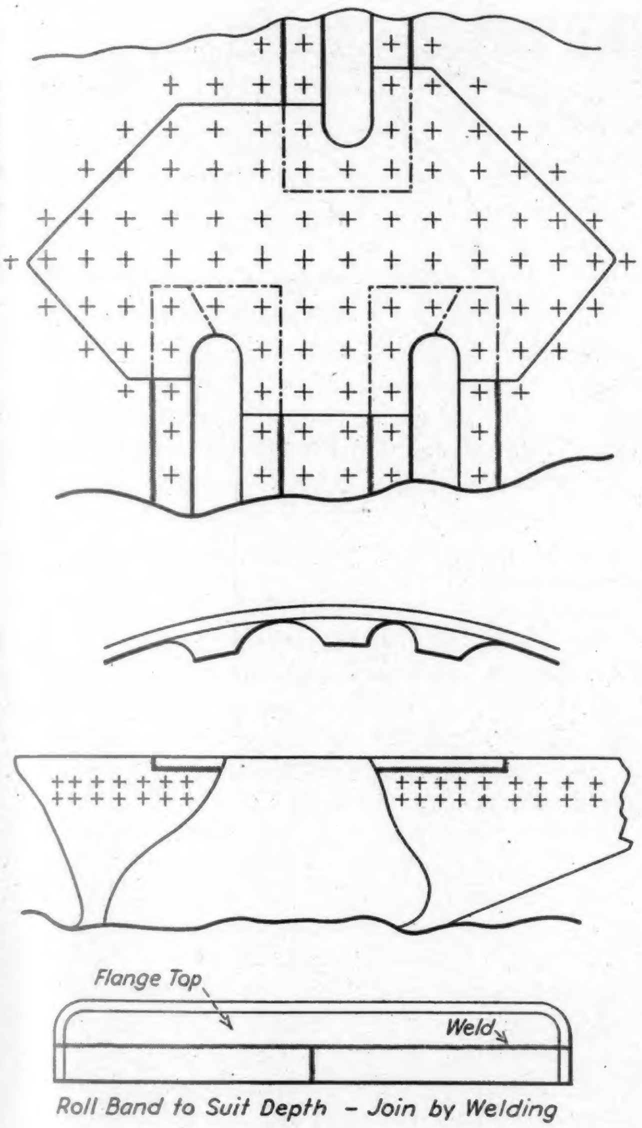
Following is a selection from a group of notes on boiler work that formed part of the report:

Manufacturing of Boilers

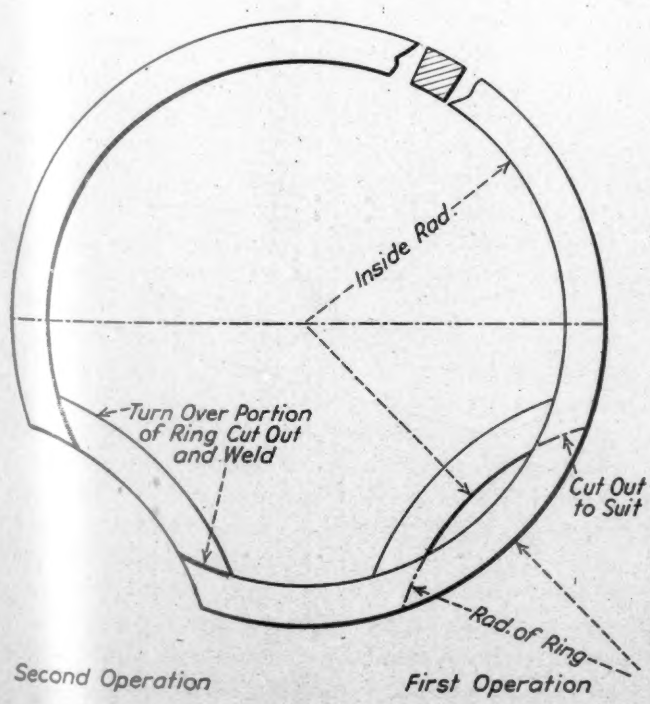
In using alloy steel for boiler courses, the plate should be scalloped at both ends for the proper radius. Sheets should be run through the roller with a slight touch and run in this manner until a true circle is reached.

All plates, making up the seams in boilers, should be fitted metal to metal by using fitting up bolts in every other hole. The open holes are then to be reamed to required size and chamfered slightly inside and outside. Rivets should then be driven in all open holes. The fitting up bolts are next removed, the rest of the holes reamed, chamfered, and rivets driven.

Chamfering should be done on all holes in the boiler in order to prevent cracks developing out of holes with sharp edges. In all cases, where seams or caulking edges are to be sealed by welding, use a flat tool to caulk seams instead of the regular standard type (fuller square tool). It has also been proved that any seam or caulking edge on which a standard type caulking tool has been used has a tendency to lift the edge, thereby forming an opening between rivet hole and edge; the use of a flat tool for caulking does not show this wedge action.



Above: Figs. 1 and 2—Below: Fig. 3



Side Sheets

Many individual solutions to this problem have been advanced from time to time; but it is still one of the most perplexing problems facing the boiler maintainer and is, so far as we can see, still unsolved.

Several papers mention high firing rates which cause a trend toward a high heat-resisting firebox steel. This indicates a step toward a permanent cure.

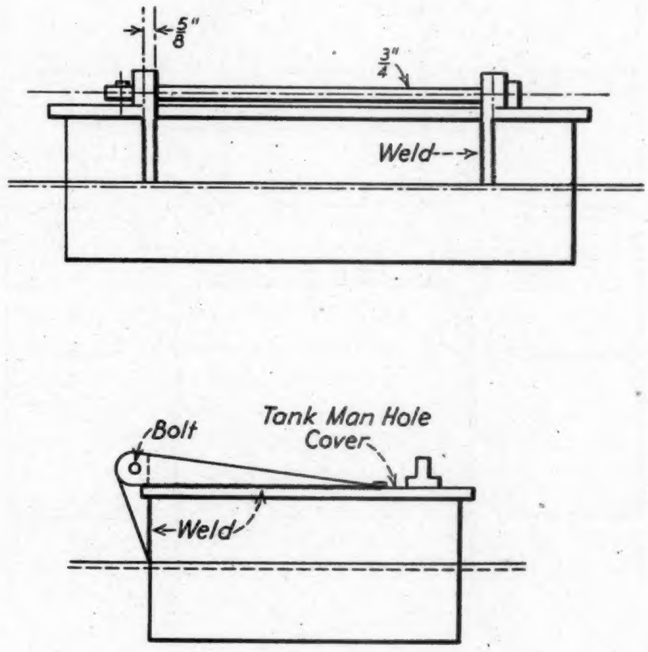


Fig. 4

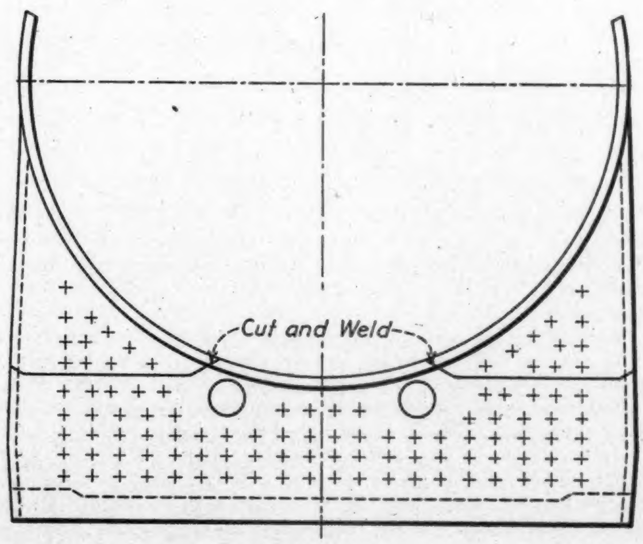


Fig. 5

Gas Welding and Cutting

Among many improved methods, none approached the advantages that have and are being offered by the use of the oxy-acetylene process for the cutting and welding of ferrous, alloys and non-ferrous metals.

A recent innovation is that of a gouging nozzle used for cutting grooves, repairing a plate edge for welding, removing arc welds for renewal, removing welded flue heads, etc.

Stationary automatic shape cutting machines are now an important and necessary part of modern shop equipment. This is not only an aid to increased production but a precision tool which makes for greater accuracy in preparing plate of any prac-

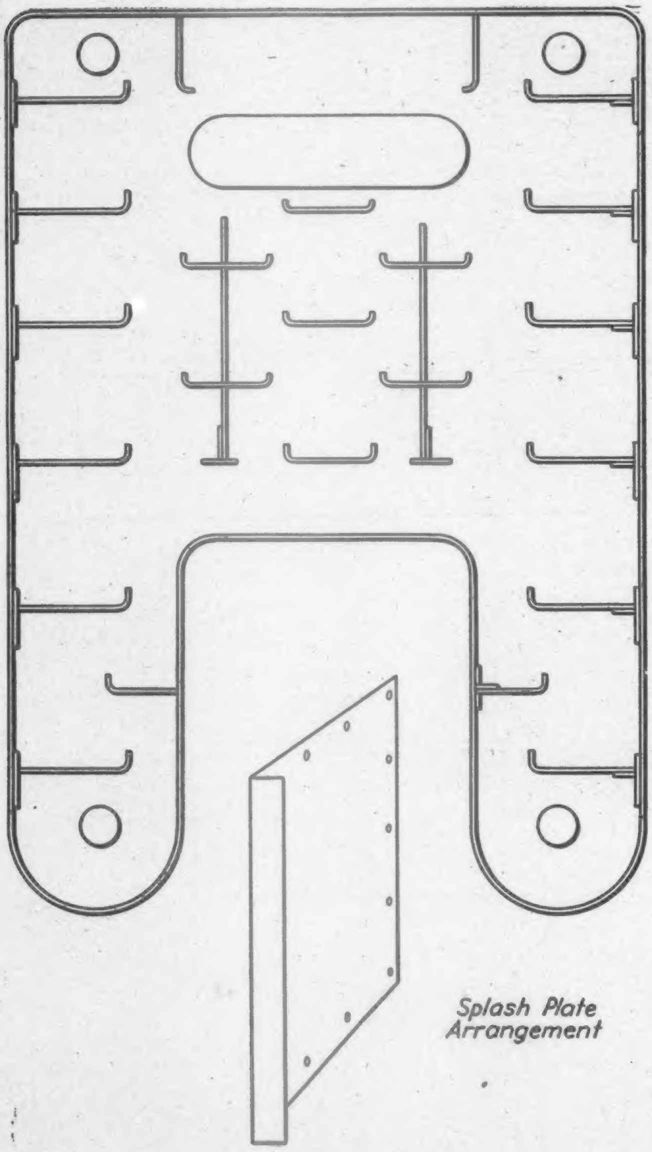


Fig. 6

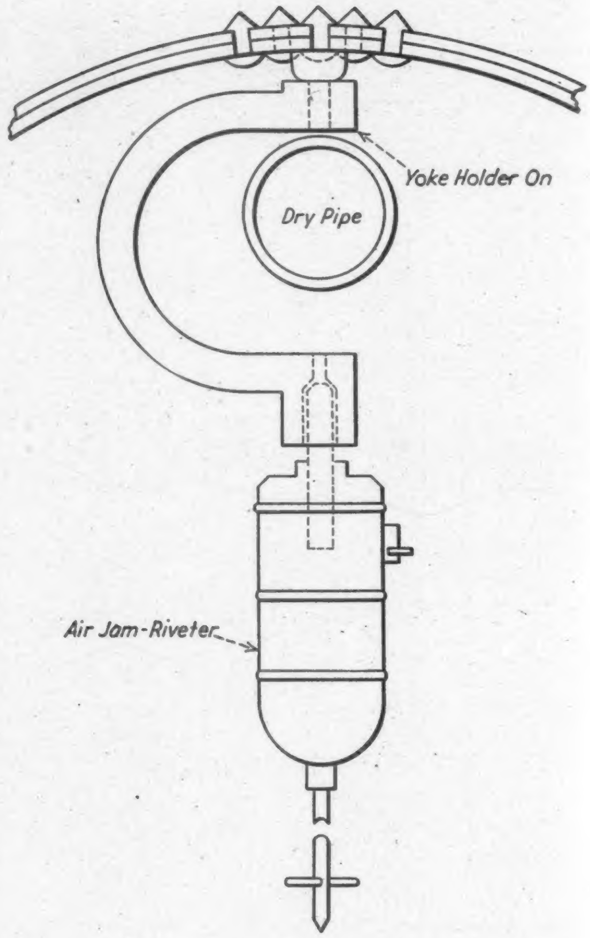


Fig. 7

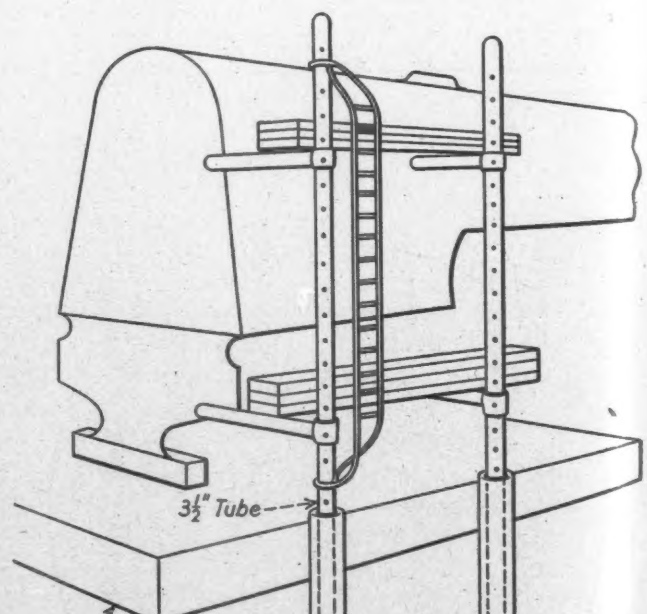


Fig. 8

tical dimension or thickness for assembling and fabrication. Many shops have from 225 to 300 regular operations assigned to such machines.

Multiplicity of parts is accomplished by the attachment of from one to four blowpipes and for the piling of plate where accurate duplication at low cost is a factor. To augment these facilities, portable mechanical driven units are also available and used extensively. Machine cutting caulking edges without subsequent chipping is now standard in many shops.

Special designs of blowpipes are now available for cutting flexible staybolt sleeve openings in wrapper sheets. Adjustment for variable diameters makes possible the cutting of washout plug holes, arch tube plug openings, etc.

The introduction of large gas capacity welding blowpipes facilitates the heating of areas where localized application is important and, therefore, offers many economies in boiler shop work. The flanging of door holes, sharp corner flanges, laying up of sheets, preparation of patches, bending angle iron and other structural shapes with the blowpipe are not uncommon operations.

The report was signed by S. Christopherson (chairman), supervisor boiler inspection and maintenance, N. Y. N. H. & H.; B. C. King, general boiler inspector, N. P.; A. T. Hunter, assistant general boiler inspector, A. T. & S. F.; Frank C. Hasse; J. W. Kennefic, service engineer, Air Reduction Sales Co.; J. F. Becker; E. J. Brennan, general boiler foreman, B. & M.; V. B. Vogel, supervisor of welding, C. R. I. & P.; H. P. Butler, chief boiler inspector, Bangor & Aroostook, and D A. Stark, general boiler and mechanical inspector, L. V.

EDITORIALS

Conventions—Good! But Not Good Enough?

Before the meetings of the four so-called coordinated associations were held at Chicago on September 23 and 24, there was a general feeling of uncertainty as to their success. Many were of the opinion that, under present conditions, the attendance would be light; indeed, there were those who advocated cancelling the meetings. It is true that the registered attendance at the meetings this year was considerably lower than last year, with the exception of the Master Boiler Makers' Association which was appreciably larger.

In appraising the causes for this general reduction in attendance, it must be remembered that last year's meeting had all the stimulus of an extensive exhibit and none of the discouragement of the defeatist psychology engendered this year by those who are normally lukewarm or positively opposed to association activities, and by others who lack the courage of their convictions. The fact that more than 1,000 members and railroad guests of the four associations were in attendance at the two-day meetings is surely evidence of a very wide interest, and that the associations enjoy the support of many American railway managements. As President Raymond said, in opening the first session of The Railway Fuel and Traveling Engineers' Association, such meetings were never of greater importance than under present conditions of stress in the railway industry.

Word has gone out that no meetings of this or any of the other coordinated associations are to be held next year. This is in keeping with the recently announced decision of the Mechanical Division, Association of American Railroads, not to hold a full-membership meeting but to return to the practice of the depression years of convening the committee chairmen with the Executive Committee for the purpose of presenting the reports of the work done by the committees during the year.

In the case of the Mechanical Division, the effect on its work of the cancellation of a full-membership meeting is not serious. With the large and representative membership on most of the committees, the ground has been thoroughly canvassed before the reports are finally presented. Furthermore, final action in the matter of standards or recommended practice is taken by letter ballot after the meeting.

Such is not the case, however, with the voluntary associations of supervisors whose work is not concerned primarily with the development of official standards, but deals in the realm of craftsmanship and the problems of supervision in which personal experience is of great importance.

These associations can make committee assignments and reports can be prepared and distributed to the members in printed form. Indeed, the four associations have already decided to proceed with next year's work on that basis. Fully half of the value of this work will be lost by this procedure, however, because it lies in the give-and-take of opinion brought out in the discussion on the floor as well as in the more intimate exchange of experience and opinion which takes place outside of the meeting rooms.

It is unfortunate that the Mechanical Division has chosen to discourage meetings of these organizations. The value which comes to the members through these exchanges, as well as through the intangible spur to the will to greater accomplishment, otherwise called inspiration, will be sorely needed by the railroads next year—and every year.

Three Mechanical Officers On Association Work

It should be highly encouraging to the men who have given liberally of their own time and energy to keep the work of the so-called Co-ordinated Associations going and to improve its quality that the value of their efforts are not without understanding and appreciation on the part of the heads of the mechanical departments of some of the large railway systems. Witness the remarks made by three of them before the recent meeting of the Car Department Officers' Association at Chicago.

E. B. Hall, chief mechanical officer, C. & N. W., and a member of the Mechanical Division, General Committee, referred to the difficulty in securing working committees and competent chairmen, without whom the activities of any group such as the Car Department Officers' Association are essentially curtailed and crippled. He said: "I have arrived at the conclusion, which to some extent may be an admission on my part, that the remedy for this lies largely in the hands of mechanical department heads. More car- and locomotive-department officers must be given permission to attend conventions of this character. Men selected for committee work must be given to understand that their supervisors encourage and support activity of this nature. That they be given full release from their railroad assignments to attend committee meetings when called is evidently very necessary. In other words, a more tolerant and co-operative spirit toward associa-

tion work on the part of mechanical-department heads is necessary. You may rest assured that I will do everything within my power to accomplish that result."

In concluding his address, D. S. Ellis, chief mechanical officer, C. & O., and also a member of the Mechanical Division General Committee, said, "I wish to congratulate President Krueger and the entire membership of this association on the excellent work you are doing . . . I wish you every success and express the fond hope that we all may never grow too old to learn."

K. F. Nystrom, mechanical assistant to the chief operating officer, C. M. St. P. & P., and past president of the Car Department Officers' Association, recalled the days when the Association was struggling for existence and said it was a great satisfaction to him personally to see such a successful meeting of an association which the railroad he represents is standing behind and expects to continue to support wholeheartedly.

Association Work—A Task Or A Personal Opportunity?

When a man is placed in a position of responsibility his obligation, both to himself and to the industry in which he serves, increases in proportion. The experience he gains in carrying on his daily work equips him for greater responsibility but involves him in a situation wherein he must continually look to many other sources than his immediate surroundings and associates for the knowledge he requires for the successful conduct of his job. Fortunately his own work provides him with a valuable asset which he can trade with other men in the same industry and in the process both the individuals and the industry profit.

No one with any breadth of vision would discount the work of an association as a means of extending the knowledge and experience of men in industry to all others in the same field of endeavor, but there seem to be many who do not fully appreciate the potential value of an affiliation with an organization the purpose of which is to promote the best interests of those within that organization and the industry which it serves.

What this value is and the manner in which it may be extended to the individual was rather well summed up by J. C. Miller, retiring president of the Locomotive Maintenance Officers' Association when, in addressing the membership, he said: "There is real need in organizations such as ours for painstaking study and investigation which can best be accomplished by committees made up of men from various sections of the country who work under a variety of conditions. The gathering and assembling of material in a report is in itself a challenge to the thinking and better performance of those who take part in the project, and when the report is finally discussed by the association and disseminated it is a practical and substantial contribution to the entire membership.

"It is not an easy task to perform successful committee work. Techniques must be developed, unless men are available who have had considerable experience in working on committees for other organizations. Unfortunately the 'lean thirties' deprived most of our members of such experiences. We have a lot to learn in this respect. We may have deliberately to seek for men as new members who can be helpful in this way. If we are alert and open minded and seriously study how to make committee work more effective we can overcome the handicap.

"The reports presented at this meeting . . . are not a 100 per cent job. They are, however, the foundation of something that can be built into an invaluable structure in the years to come. They represent the medium through which data on the variety of practices involved in repairing locomotives can be co-ordinated and presented to the industry in a manner that it can be used to advantage. There is no better way in which the ideas of practical men can be brought together and made available to all."

There, in a few words, is a plain statement concerning what an association can accomplish accompanied by specific suggestions as to how it may be done and the value that may be expected to accrue as a result.

At this moment, with a year of convention work fresh in the minds of all association officers and committee chairmen, there are many who have been charged with the responsibility of bringing a convention program to a successful conclusion who may be very much inclined to feel that it has not been worth the effort. Why do they feel that way about it? In the answer to this question may be a clue to a weakness of some associations.

In order to carry on constructive committee work, particularly with respect to technical subjects, an association's several committees should have an element of permanence as regards personnel—permanence in the sense that the make-up of a committee should be such that there may always be some members with one or more years experience in committee work. It is upon these experienced men that the association must rely to carry on the work of that committee in accordance with the established policies of the organization and in a manner that will produce the type of final report that will be of maximum value to the people in the industry who hope to add to their knowledge by the use of the report. It is not a difficult matter for railroad supervisors to sit down, in some moment when the demands for more, and still more, locomotives and cars is not too pressing, and analyze carefully the proceedings of their favorite association and decide for themselves whether or not the material they have before them is of real value to them in their work. Nine times out of ten the answer may be that the report they have under consideration is lacking in some important respect—it may be that important data is missing; that a line of investigation was not followed, by the committee, to a logical conclusion or that the information at the committee's dis-

(Continued on next left-hand page)

posal was not organized and presented in a manner to be readily understandable.

If the job done by the committee fails to measure up to your specifications there lies your obligation and your opportunity. Exercise your right as a member to insist on a better job being done and demonstrate your sincerity by putting your shoulder to the wheel when asked to help. The experience you get will fit you for greater responsibility.

Priorities Have Outlived Their Usefulness

The present system of priorities has outlived its usefulness. Originally intended for application to a limited list of critical materials, against civilian demands for which strictly defense products had to be protected, the situation has rapidly advanced to a point where a tremendous list of materials essential alike to the continued functioning of our industrial machine as well as to the output of strictly defense products are under priority control.

The effect of this control is highly detrimental to railway transportation. The delivery of cars has fallen behind the needs of the railroads during the current year and prospects for future deliveries are so discouraging at the present time that the placing of orders has almost ceased.

Few machine tools are used directly by military forces. The reason for priority protection of the machine-tool industry during past months lay in the need for machine tools to equip the new plants required to produce the tremendously expanded volume of defense products demanded by the national government. Transportation is as essential a part of our national establishment for the production of defense equipment and materials as are the industries whose products are ordered directly by the military departments of the national government, which is only another way of saying that locomotives and cars are of equal importance with machine tools.

A failure of transportation because the railways have been unable to expand their supply of equipment sufficiently to meet the tremendous increase in traffic, present and prospective, will cause just as complete a failure of the national effort to carry out the defense program as will a direct failure of any of the plants producing them, to meet the planned outputs of airplanes, tanks, guns, shells, or ships.

Until the minimum current needs for expanded facilities of transportation as well as of other essential industries are taken into account as of equal importance with the needs for strictly defense products, the government allocation of materials is based upon unreality. The railroads, as well as other essential links in the chain of our national productive establishment, must be accorded their share of all essential materials currently without any question of priority. Only thus can the establishment be kept in a state of balance by which the greatest output of defense materials can be produced—and delivered where they can be used.

New Books

PROCEEDINGS OF THE 1940 ANNUAL MEETING OF THE CAR DEPARTMENT OFFICERS' ASSOCIATION. *F. L. Kartheiser, Secretary-Treasurer, Chief Clerk, Mechanical Department, C. B. & Q., Chicago. 288 pages, Price, $3.*

This book contains the full proceedings of the 1940 annual meeting of the Car Department Officers' Association held at Hotel Sherman, Chicago, October 22 to 25 of last year. Included in the proceedings are two addresses made by railroad officers on the subject of car maintenance and eight technical committee reports. The technical reports are included in detail, with the discussion by the members, and cover the following subjects: Freight and passenger car maintenance; shop operation, facilities and welding; terminal handling of passenger train cars and air conditioning; inspection of freight cars and their preparation for commodity loading; interchange and billing for car repairs; loading rules and painting. The book also contains a directory of the membership.

MACHINE SHOP TRAINING COURSE—*Second Edition. By Franklin D. Jones. Two volumes, 6 by 9 inches. Volume 1, 538 pages, 334 illustrations; Volume 2, 552 pages, 209 illustrations. Published by The Industrial Press, 148 Lafayette St., New York City. Price, complete two-volume course, $6; Volume 1 or 2, if purchased separately, $4.*

This second edition of Machine Shop Training Course is practically the same as the first edition with the exception of some additional matter of considerable importance to many students of machine shop practice. This two-volume treatise—which is especially designed for shop courses, technical trade schools, and also for self-instruction—now has, as one extra feature, an original series of blueprint reading charts. This series of twenty-nine full-page charts, all in color, shows by a simple progressive method just how to read or understand mechanical drawings. Each chart consists of from two to five drawings especially selected to illustrate, step by step, the fundamental principles underlying blueprint reading.

These charts are supplemented by a series explaining the meanings of various standard abbreviations or symbols. Typical applications of these abbreviations or symbols are illustrated in all cases by means of detail drawings. American Standard screw thread symbols, as well as standard cross-section lines for different materials, are included in this series.

Another feature of the second edition is a chapter on "Engineering Standards Applied in Machine Building." The purpose of this chapter is to give information that will be useful not only in shop work but also in the reading of mechanical drawings.

(*Turn to next left-hand page*)

From a white hot billet . . . To a cold steel rod

LIMA QUALITY IS "POUNDED-IN" EVERY STEP OF THE WAY

From the time a potential Lima piston rod leaves the heating furnace until it is placed on a locomotive "ready for service", it undergoes the rigid tests for quality and tolerances that have earned for Lima its reputation as a builder of high-performance, low-maintenance locomotives. The illustration above is a typical scene at Lima showing the first step in fabricating a "Lima Quality" Piston Rod.

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High Spots in

Railway Affairs . . .

Emergency Board At Work

The Emergency Board in the railway wage controversy announced at the outset of the hearings on September 16 that it could not complete the hearings and make its report to the President within 30 days. At its request the President granted an extension of time to November 1. The formal hearings will extend beyond the middle of this month. The Board's problem is complicated by the fact that it must not only consider the demands of the operating and non-operating employees, but it has also taken jurisdiction in the Railway Express controversy, because of a threatened strike of those employees on September 13. The order in which the evidence will be presented follows: (1) Non-operating employees' vacation and wage demand; (2) operating employees' wage demand; (3) railways' reply to these demands; (4) carriers' proposal to change working rules; (5) employees' reply; (6) express employees' demand; (7) Express Company's reply. Thirty days must elapse after the report is made to the President before either side in the controversy can take action.

Emergency Board Chairman

What sort of man heads up the Emergency Board? Since 1938 Wayne Lyman Morse, dean of the law school, University of Oregon, has functioned with signal success as a United States Department of Labor arbitrator, with the task of interpreting and enforcing the master agreement which governs the relations between longshoremen and ship operators on the Pacific Coast. Recently he has served as a "public" member of two industry committees set up by the Department of Labor's Wage and Hour Division, to determine minimum wages under the provisions of the Fair Labor Standards Act. Native of Madison, Wis., 41 years of age, a graduate of the University of Wisconsin, he took his law course at the University of Minnesota and did graduate work at Columbia University.

Other Emergency Board Members

The Emergency Board, of which Dean Morse is chairman, has four other members. James Cummings Bonbright, professor of finance at Columbia University, is the author of books on railroad capitalization, holding companies and utility valuation. Since 1939 he has been chairman of the Power Authority of the State of New York, which favors public ownership and development of power resources and is for the St. Lawrence seaway and power project. Native of Evanston, Ill., about 50 years of age, Dr. Bonbright is a graduate of Northwestern University and has a Ph. D. degree from Columbia University. Thomas Reed Powell, professor of law at Harvard Law School, has been a law teacher and law lecturer at various colleges. He is the author of several books on political subjects and during 1936 was special assistant to the United States Attorney General. Born at Rockford, Vt., he is 61 years old. He is a graduate of the University of Vermont and received his LL. B. degree from Harvard Law School. Huston Thompson, attorney, Washington, D. C., is the one member of the board who has had previous Emergency Board experience. He was chairman of a three-man board which considered the wage demands of the Atlanta, Birmingham & Coast train and yard service employees early this year. He served a term on the Federal Trade Commission. Born in Lewisburg, Pa., and 66 years old, he is a graduate of Princeton University. He studied law at the New York Law School. Joseph Henry Willits, director for social science, Rockefeller Foundation, has had a long record in the field of social service and labor relations. Prior to joining the Rockefeller Foundation he was dean of the Wharton School of Finance and Commerce of the University of Pennsylvania for several years. Born in Ward, Pa., and 52 years of age, he is a graduate of Swarthmore College.

Railroad Workers' Wages

There are several methods of calculating the average wage of railroad workers, but because of the conflicting interests involved, there apparently always will be differences of opinion as to just which one is most equitable. The Railroad Retirement Board, as an example, has made a compilation showing that, considering all railroad employees, including 102,388 who had worked in only one month of the year, and 129,927 who had earned less than $50. during the year, the average 1939 wage was $1,324. Obviously there were included in this compilation thousands and thousands of workers who could in no sense be regarded as regular railway employees. The Railroad Retirement Board in another calculation found that 862,153 employees had done some work on the railroad in each month in 1939, and that the average earnings of this group amounted to $1,844. These figures, incidentally, exclude pay in excess of $300. a month. The Bureau of Statistics of the Interstate Commerce Commission has approached the problem in still another way. Its compilation is based on average compensation for the mid-month count of employees and amounts to $1,839, or a little lower than the $1,844 figure of the Retirement Board.

Transport Study Board Gets Started

The Transportation Act, which was finally passed and approved by the President in September, 1940, called for the establishment of a Board of Investigation and Research, to make a thorough study of the transportation system in this country, and make recommendations as to how the various types of carriers might best be developed in the public interest. Because of the delay in appointing the board, it was impossible for it to make a preliminary report on or before May 1, 1941, as called for in the Act. As a matter of fact, the three members of the board did not take the oath of office until August 22, and so were hard put to it to prepare an annual report. The board is attempting to gather the necessary information, with the co-operation of private and governmental agencies, and thus to avoid unnecessary and wasteful duplication of effort. While $100,000 was appropriated for the board's work, it plans, after it has more thoroughly explored the situation, to ask for additional funds "to enable it to function effectively." Its offices are in the Dupont Circle Apartments Building, Washington, D. C.

Calls on Shippers For Co-operation

Ralph Budd, defense transportation commissioner, recently pointed out that the difficulty in obtaining materials for the building of new railroad equipment had resulted in a lagging in the car building program, to the extent that 20,000 less new cars were in service on October 1 than provided for by the railroads. He made a special appeal to the president of the National Association of Advisory Boards and the president of the National Industrial Traffic League for cooperation on the part of the shippers. Mr. Budd pointed out that "the important part which shippers and receivers play in efficient utilization of freight cars has long been recognized." He said also, "During the next several weeks, in order that everyone desiring transportation service may receive it currently without delay, new records in the volume of transportation rendered per unit of serviceable equipment must be made. This appeal to all users of transportation to renew during the coming weeks their previous efforts to eliminate all wasteful use of transportation, and particularly to urge all to do everything in their power to prevent delay to cars while awaiting loading or unloading, is made in the interest of the general welfare. A few hours and a few dollars spent in loading or unloading cars seven days a week or after usual closing time may well pay large dividends to the shippers directly involved, and to the country as a whole."

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Among the Clubs and Associations

Car Department Association of St. Louis.—Meeting October 21 at 8 p. m. at Hotel DeSoto, St. Louis, Mo. Subject: Roller Bearings—Their Installation and Maintenance. Speaker: Paul N. Wilson, sales engineer, Railway Division, Timken Roller Bearing Company.

Eastern Car Foremen's Association.—Meeting 8 p. m., October 10, Engineering Societies building, New York. Speaker: Charles R. Busch, vice-president, Unit Truck Corporation. Subject: Unit Trucks, with slides illustrating mechanics and handling of the unit truck.

W. H. Winterrowd and C. B. Peck Elected A. S. M. E. Vice-Presidents

W. H. Winterrowd, vice-president of the Baldwin Locomotive Works, Eddystone, Pa., and C. B. Peck, managing editor of "Railway Mechanical Engineer and mechanical department editor of *Railway Age*, New York, were among four elected vice-presidents of the American Society of Mechanical Engineers by a letter ballot of its 15,000 members, the results of which were announced recently. Elected president of the society was J. W. Parker, vice-president and chief engineer of the Detroit Edison Company. Other vice-presidents elected were C. F. Freeman, senior vice-president and engineer, Manufacturers Mutual Fire Insurance Company, Providence, R. I., and W. R. Woolrich, dean of the College of Engineering, University of Texas, Austin, Tex.

Mr. Winterrowd was born at Hope, Ind., on April 2, 1884, and was graduated from Purdue University with the degree of B. S. in M. E. in 1907, receiving his doctorate degree in 1936. He entered railroad service in 1905 as a blacksmith's helper on the Lake Erie & Western (now New York, Chicago & St. Louis) at Lima, Ohio, and in 1906 became car and air brake repairman for the Pennsylvania, Lines West of Pittsburgh, at Dennison, Ohio. A year later he became special apprentice for the Lake Shore & Michigan Southern (now New York Central). In 1908 Mr. Winterrowd went with the Lake Erie, Alliance & Wheeling (now New York Central) as enginehouse foreman, becoming night enginehouse foreman at Youngstown, Ohio, for the Lake Shore & Michigan Southern the following year. He then served with the latter road as roundhouse foreman at Cleveland, Ohio, and assistant to mechanical engineer, successively. From 1912 to 1918 he was mechanical engineer for the Canadian Pacific, and from 1918 to 1923, chief mechanical engineer of that road. He was assistant to president of the Lima Locomotive Works at New York from 1923 to 1927, when he became vice-president of that company. In 1934 he became vice-president of the Franklin Railway Supply Company at Chicago, the position he held until 1939 when he became vice-president in charge of operations of the Baldwin Locomotive Company.

Mr. Peck was born at Pierson, Mich., on June 24, 1884, and was graduated from Michigan Agricultural College with the degree of B. S. in M. E. in 1907. He entered railroad service in 1907 as draftsman on the Duluth, South Shore & Atlantic at Marquette, Mich., holding this position until 1911. From the latter year until 1914 he was assigned to special duties in the mechanical engineer's office of the Atchison, Topeka & Santa Fe at Topeka, Kan. From 1914 to 1919 Mr. Peck was associate editor, Mechanical edition, Railway Age Gazette, New York, and from 1919 to 1923 served as Western mechanical editor of Railway Age and "Railway Mechanical Engineer" at Chicago. In 1923 Mr. Peck became managing editor, *Railway Mechanical Engineer* and mechanical department editor, Railway Age.

DIRECTORY

The following list gives names of secretaries, dates of next regular meetings, and places of meetings of mechanical associations and railroad clubs:

Allied Railway Supply Association.—J. F. Gettrust, P. O. Box 5522, Chicago.

American Society of Mechanical Engineers.—C. E. Davies, 29 West Thirty-ninth street, New York.

Railroad Division.—C. L. Combes, *Railway Mechanical Engineer*, 30 Church street, New York City.

Machine Shop Practice Division.—Warner Seely, Warner & Swasey Co., 5701 Carnegie avenue, Cleveland, Ohio.

Materials Handling Division. — F. J. Shepard, Jr., Lewis-Shepard Co., Watertown Station, Boston, Mass.

Oil and Gas Power Division.—L. N. Rawley, Jr., Power, 330 West Forty-second street, New York.

Fuels Division.—D. C. Weeks, Consolidated Edison Co., 4 Irving Place, New York.

Anthracite Valley Car Foremen's Assn.—Exec. sec., Walter B. Riggin, 215 Swartz street, Dunmore, Pa. Meets third Monday of each month at Wilkes-Barre, Pa.

Association of American Railroads.—Charles H. Buford, vice-president Operations and Maintenance Department, Transportation Building, Washington, D. C.

Operating Section.—J. C. Caviston, 30 Vesey street, New York.

Mechanical Division.—A. C. Browning, 59 East Van Buren street, Chicago.

Purchases and Stores Division.—W. J. Farrell, 30 Vesey street, New York.

Motor Transport Division.—George M. Campbell, Transportation Building, Washington, D. C.

Canadian Railway Club.—C. R. Crook, 4415 Marcil avenue, N. D. G., Montreal, Que. Regular meetings, second Monday of each month, except June, July and August, at Windsor Hotel, Montreal, Que.

Car Department Association of St. Louis.—J. J. Sheehan, 1101 Missouri Pacific Bldg., St. Louis, Mo. Regular monthly meetings third Tuesday of each month, except June, July and August, DeSoto Hotel, St. Louis.

Car Department Officers' Association.—Frank Kartheiser, chief clerk, Mechanical Dept., C. B. & Q., Chicago. Annual meeting, Hotel Sherman, Chicago, September 23 and 24.

Car Foremen's Association of Chicago.—G. K. Oliver, 8238 S. Campbell avenue, Chicago. Regular meetings, second Monday in each month, except June, July and August, La Salle Hotel, Chicago.

Car Foremen's Association of Omaha, Council Bluffs and South Omaha Interchange.—H. E. Moran, Chicago Great Western, Council Bluffs, Ia. Regular meetings, second Thursday of each month.

Central Railway Club of Buffalo.—Mrs. M. D. Reed, Room 1840-2, Hotel Statler, Buffalo, N. Y. Regular meetings, second Thursday of each month, except June, July and August, at Hotel Statler, Buffalo.

Eastern Car Foreman's Association.—W. P. Dizard, 30 Church street, New York. Regular meetings, second Friday of January, February (annual dinner), March, April, May, October, and November at Engineering Societies Bldg., 29 West Thirty-ninth street, New York.

Indianapolis Car Inspection Association.—R. A. Singleton, 822 Big Four Building, Indianapolis, Ind. Regular meetings, first Monday of each month, except July, August and September, in Indianapolis Union Station, Indianapolis, at 7 p. m.

Locomotive Maintenance Officers' Association.—J. E. Goodwin vice-president, secretary-treasurer, c/o Missouri Pacific, North Little Rock, Ark. Meeting September 23 and 24, Hotel Sherman, Chicago.

Master Boiler Makers' Association.—A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y. Annual meeting, Hotel Sherman, Chicago, September 23 and 24.

Mid-West Air Brake Club.—C. F. Davidson, secretary-treasurer, general inspector car department, St. L.-S. F., Springfield, Mo.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meetings, second Tuesday in each month, except June, July, August and September.

New York Railroad Club.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Thursday in each month, except June, July, August, September and December at 29 West Thirty-ninth street, New York.

Northwest Car Men's Association. — E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meetings first Monday each month, except June, July and August, at Midway Club rooms, 1931 University avenue, St. Paul.

Northwest Locomotive Association.—G. T. Gardell, 820 Northern Pacific Building, St. Paul, Minn. Meetings third Monday of each month, except June, July and August.

Pacific Railway Club.—William S. Wollner, P. O. Box 3275, San Francisco, Cal. Monthly meetings alternately in northern and southern California.

Railway Club of Pittsburgh.—J. D. Conway, 1647 Oliver Building, Pittsburgh, Pa. Regular meetings, fourth Thursday in month, except June, July and August, Fort Pitt Hotel, Pittsburgh, Pa.

Railway Fuel and Traveling Engineers' Association.—T. Duff Smith, Room 811, Utilities Building, 327 South La Salle street, Chicago. Annual meeting Hotel Sherman, Chicago, September 23 and 24, 1941.

Railway Supply Manufacturers' Association.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa.

Southern and Southwestern Railway Club.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings, third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

Toronto Railway Club.—D. M. George, Box 8, Terminal A, Toronto, Ont. Meetings, fourth Monday of each month, except June, July and August, at Royal York Hotel, Toronto.

Western Railway Club.—E. E. Thulin, executive secretary, Room 822, 310 South Michigan avenue, Chicago. Regular meetings, third Monday in each month, except June, July, August, September, and January.

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NEWS

Couplers With Burned Out Key Slots

EFFECTIVE August 1, 1941, the A. A. R. Mechanical Division added a new Par. 2 to Sec. C of Interchange Rule 18, which not only prohibits the burning out of key slots in any type of coupler body but requires the removal of any such couplers found in service at the expense of the car owner. Due to the present emergency in the matter of obtaining car repair materials, the second part of this new rule requiring the removal of couplers found in service with burned out key slots has been made non-effective as of September 1, the understanding being that the rule will be reinstated when conditions warrant.

Movie Night at Meeting of Co-ordinated Mechanical Associations

ON Tuesday evening, September 23, during the annual meetings of the Car Department Officers' Association, the Railway Fuel and Traveling Engineers' Association, the Master Boiler Makers' Association, and the Locomotive Maintenance Officers' Association, there was a showing of moving pictures and slides for the members and guests of the four associations. A film entitled "The Power Behind the Nation," contributed by the Norfolk & Western, illustrated the production and handling of coal from the mine to the hold of the ship at tidewater. One of two films of the United States Treasury Department dealt with the detection of counterfeit money; the other urged the purchase of Defense Savings bonds. There were also two series of lantern slides. One, contributed by the Hartford Steam Boiler Inspection & Insurance Company, showed stress concentrations in various types of welded joints by means of polarized light. The other, illustrating the effect of a case of extremely low water on a water-tube locomotive firebox, was presented by the Baltimore & Ohio. There was no serious damage to the firebox and there were no casualties.

Cars for Loading

IN a letter dated September 5, the secretary of the A. A. R. Mechanical Division called attention to complaints about the loading of unfit cars which has necessitated the stopping of these cars enroute and, in numerous cases, transferring the loads with attendant delays to important shipments, including some urgently needed for the national defense program. The secretary requested that all railroads take such action as may be necessary to assure the selection of cars for loading which may reasonably be expected to proceed to destination without delay enroute for repairs or transfer of the loads.

Particular attention is directed in the secretary's letter to the necessity of maintaining brake beam hangers, pins and other attachments in a proper state of repair at all times, and particularly prior to placing cars for loading, as the failures of these items are frequently the cause of delays to loaded cars enroute. To minimize the seriousness of delays from this cause, it is urged that car owners expedite the application of bottom rod and brake beam safety supports on existing cars in conformity with the requirements of Par. 8, Sec. B, Interchange Rule 3, and also repair or renew such devices previously applied when they are found to be defective, loose or missing on cars when on repair tracks for any reason. Such devices on foreign cars should also be repaired or renewed if proper material is available, but the release of serviceable foreign cars should not be delayed to obtain special materials from the car owner.

J. J. Tatum

ON September 17, J. J. Tatum, assistant chief of motive power and equipment, celebrated his seventy-fifth birthday, as well as his sixty-second year of consecutive service with the Baltimore & Ohio. Mr. Tatum entered railway service in 1879 as a messenger boy at the Mt. Clare, Md., shops of

J. J. Tatum

the Baltimore & Ohio. He has taken out 64 patents and eight copyrights for improvements to railroad equipment, and was among those who in February, 1940, were recipients of a Modern Pioneer Award from the National Association of Manufacturers.

Mr. Tatum supervised the building of the Adams "Windsplitter" train at the Mt. Clare shops. It was completed May, 1900, and was fitted with "shields and other devices for reducing the resistance of the air at high speed." The train consisted of five cars drawn by a standard locomotive. The tender, however, was built up to the height of the cars, so that there was no break between the engine cab and the baggage car. It is regarded somewhat as a forerunner of the modern streamliner.

Mr. Tatum was elected chairman of the Mechanical Division, A. R. A., in June, 1924. A talk made by him at about that time received widespread attention in the press, because of its novel suggestions of improvements to passenger carrying cars, including air conditioning. A few years later, in 1930, the Baltimore & Ohio air-conditioned dining car, Martha Washington, was exhibited at the Atlantic City conventions.

Five Experimental Tank Cars for A. C. F.

THE American Car & Foundry Company has been authorized by the Interstate Commerce Commission in an August 19 decision by Commissioner Johnson, to construct five riveted aluminum alloy tank cars for experimental service in the transportation of ninety-five per cent nitric acid.

Budd Names Committee to work With SPAB and OPM

RALPH BUDD, defense transportation commissioner, on September 18, announced the appointment of two committees to represent his office in working with the Supply Priorities and Allocations Board and the Office of Production Management on matters relating to the supply of materials required for construction of railroad freight cars and steam locomotives. The membership of the committee is:

COMMITTEE FOR THE CAR BUILDING INDUSTRY

C. A. Liddle, president, Pullman-Standard Car Manufacturing Co., Chicago.
C. J. Hardy, president, American Car and Foundry Company, New York.
Lester N. Selig, president, General American Transportation Corp., Chicago.
Edwin Hodge, Jr., president, Greenville Steel Car Company, Greenville, Pa.
A. Van Hassel, president, Magor Car Corporation, Passaic, N. J.
F. A. Livingston, president, Ralston Steel Car Company, East Columbus, Ohio.
J. F. MacEnulty, president, Pressed Steel Car Company, Pittsburgh, Pa.

COMMITTEE FOR THE STEAM LOCOMOTIVE INDUSTRY

W. K. Farrell, general purchasing agent, American Locomotive Company, New York.
W. H. Harman, vice-president, Baldwin Locomotive Works, Philadelphia, Pa.
L. A. Larsen, vice-president, Lima Locomotive Works, Inc., Lima, Ohio.
G. W. Alcock, secretary, Locomotive Institute, New York.

Orders and Inquiries for New Equipment Placed Since the Closing of the September Issue

Locomotives

Road	No. of Locos.	Types of Locos.	Builder
Alabama Drydock & Ship Bldg. Co.	2	20-ton Diesel hydraulic	Whitcomb Loco. Co.
Aluminum Ore Co.	1	25-ton Diesel hydraulic	Whitcomb Loco. Co.
Arundel Corp. & Con. Engrg. Co.	10	30-ton Diesel hydraulic	Whitcomb Loco. Co.
Baker Co., J. E.	1	20-ton Diesel hydraulic	Whitcomb Loco. Co.
Bethlehem Steel Co.	5	50-ton Diesel-elec.	Whitcomb Loco. Co.
Chicago & North Western	1	80-ton Diesel-elec.	Whitcomb Loco. Co.
Crucible Steel Company	1[1]	65-ton fireless steam	H. K. Porter Co.
General Supply Co. of Canada	1	30-ton Diesel hydraulic	Whitcomb Loco. Co.
Louisiana Shipyards, Inc.	1	20-ton Diesel hydraulic	Whitcomb Loco. Co.
Louisiana Southern	1	45-ton Diesel-elec.	General Elec. Co.
National Railways of Mexico	2	44-ton Diesel-elec.	General Elec. Co.
Norton Company	1	75-ton fireless steam	H. K. Porter Co.
Pennsylvania Power & Light Co.	1[2]	95-ton fireless steam	H. K. Porter Co.
Republic Mining & Mfg. Co.	3	20-ton Diesel hydraulic	Whitcomb Loco. Co.
Sheffield Steel Corp.	2	50-ton Diesel-elec.	Whitcomb Loco. Co.
Southern Pacific	15[3]	1,000-hp. Diesel-elec.	American Loco. Co.
	5[3]	1,000-hp. Diesel-elec.	Baldwin Loco. Wks.
Stone & Webster Engrg. Co.	1	47-ton fireless	H. K. Porter Co.
United States Army	1	65-ton Diesel-elec.	General Electric Co.
	8	2-8-0	Lima Loco. Wks.
United States Government,[4] Tennessee Valley Authority	...	....	Whitcomb Loco. Co.
United States War Dept.	1	45-ton Diesel-elec.	Whitcomb Loco. Co.
	10	20-ton Gas-mech.	Whitcomb Loco. Co.
	5	20-ton Gas-mech.	Davenport-Besler Corp.
	5	20-ton Gas-mech.	Vulcan Iron Works
Washington & Old Dominion	3	44-ton Diesel-elec.	General Electric Co.
Westinghouse Elec. & Mfg. Co.	1	50-ton Diesel-elec.	Whitcomb Loco. Co.

Locomotive Inquiries

Road	No. of Locos.	Types of Locos.	Builder
National Steel Co. of Brazil	6	0-6-0	....
	2	0-8-0	....
United States Navy Dept.	2	Diesel-elec.	....
United States War Dept.[5]	100-200	2-8-2	....

Freight-Car Orders

Road	No. of Cars	Type of Cars	Builder
Atchison, Topeka & Santa Fe	200	70-ton tank	Gen. Amer. Transp. Corp.
	75	70-ton hopper	Gen. Amer. Transp. Corp.
	200	Caboose	Company shops
Bethlehem Steel Co.	100	Gondola	Company shops
Canadian Pacific	50	70-ton hopper	Eastern Car Co.
Chicago, Indianapolis & Louisville	300	50-ton box	Pull.-Std. Car Mfg. Co.
Michigan Limestone & Chemical Co.	20	Dump	Austin-West. Road Mchy. Co.
Missouri Pacific[6]	1,450	50-ton box	American Car & Fdry. Co.
	50	50-ton hopper	American Car & Fdry. Co.
	50	70-ton coal	Mt. Vernon Car Mfg. Co.
	500	70-ton hopper	Pull.-Std. Car Mfg. Co.
	650	50-ton gondola	Pressed Steel Car Co.
	150	50-ton flat	Bethlehem Steel Co.
Reading	58	Caboose	Company shops
Southern	11	50-ton box	Pull.-Std. Car Mfg. Co.
Southern Pacific[7]	130	70-ton flat	Company shops
	10	70-ton dep. center flat	Company shops
	90	70-ton gondola	Company shops
	165	Cabooses	Company shops
United States Army	4[8]	Two-way dump	Austin-West. Road Mchy. Co.
United States Army,	3[9]	Tank	Gen.-Amer. Transp. Corp.
Engineering Dept.	..[10]	Dump	Pressed Steel Car Co.

Freight-Car Inquiries

Road	No. of Cars	Type of Cars	Builder
Hicks, C. D. & Co.	300	Tank	....
Carnegie-Illinois Steel Corp.	3	50-ton hopper	....
National Rwys. of Mexico	150	40-ton stock	....
	150	50-ton gondola	....
	100	50-ton flat	....
Tennessee Coal, Iron & R. R. Co.	10	70-ton air-dump	....
Norfolk & Western	25	70-ton hopper	....
Union Pacific	100	Cabooses	....
United States Navy Dept.	10	40-ton box	....
	12	40-ton flat	....

Passenger-Car Orders

Road	No. of Cars	Type of Cars	Builder
Louisville & Nashville	3[11]	Coaches	Edw. G. Budd Mfg. Co.

[1] Delivery received.
[2] Delivery received. Reported to be largest fireless steam locomotive ever built.
[3] Order unconfirmed.
[4] Cost, $70,200.
[5] Inquiry unconfirmed.
[6] Orders for the Missouri Pacific, Gulf Coast Lines, International-Great Northern and the Missouri-Illinois.
[7] For 1941 and 1942 delivery.
[8] At a cost of $12,193.
[9] Cost, $11,335.
[10] Cost, $43,825.
[11] The company expects to place two of these cars in service with the "Southwind" and one with the "Dixie Flagler," the Chicago-Florida coach trains operated over this railroad's lines between Louisville, Ky., and Montgomery, Ala., and between Evansville, Ind., and Nashville, Tenn., respectively.

Equipment Purchasing and Modernization Program

Chicago & North Western.—An improvement program costing approximately $450,000 is under way in the Chicago & North Western shops in the Chicago area. The principal feature of this project is the construction of a servicing yard for streamlined trains in the vicinity of the company's shops at Fortieth street and the transfer of the present servicing facilities for these trains to the new location. This necessitates the building of three inspection pits for the inspection of complete trains and power plants, suitable drop pits for changing wheels and a transfer table to permit changing of complete power trucks under the Diesel-electric locomotives. The pits have been designed so that duplicate servicing units may be added later as required. The estimated cost of this project alone is approximately $370,000. Other work in the program includes the construction of a mechanical drop pit table, an extension to the machine shop for repair work on locomotives and the construction of a locomotive blow-off tank at Proviso, Ill.

Denver & Rio Grande Western.—The D. & R. G. W. has asked the Interstate Commerce Commission for authority to assume liability for $1,260,000 of two per cent equipment trust certificates, maturing in 10 equal annual installments of $126,000 on November 1 in each of the years from 1942 to 1951, inclusive. The proceeds will be used as a part of the purchase price of new equipment costing a total of $1,692,460 and consisting of 500 50-ton, 40 ft. 6 in. box cars.

Missouri Pacific.—The Missouri Pacific has asked the Interstate Commerce Commission for authority to assume liability for $1,150,000 of equipment trust certificates, maturing in 10 equal annual installments of $115,000 on October 15 in each of the years from 1942 to 1951, inclusive. The proceeds will be used as a part of the purchase price of new equipment costing a total of $1,442,500 and consisting of two 4,000 hp. Diesel-electric passenger locomotives and 11 streamline, stainless-steel passenger cars. The passenger cars to be: One mail-storage car, two baggage-express cars, two baggage-mail cars, two deluxe coaches, two coach-grill crew cars, and two diner-lounge cars.

New York, Chicago & St. Louis.—The New York, Chicago & St. Louis has asked the Interstate Commerce Commission for authority to assume liability for $5,800,000 of serial equipment trust certificates, bearing interest at not more than three per cent and maturing in 10 equal annual installments of $580,000 on September 1 in each of the years from 1942 to 1951, inclusive. The proceeds will be used as part of the purchase price of new equipment costing a total of $6,589,128 and consisting of 15 class S-1, 2-8-4 freight locomotives; 250 all-steel, 50-ton hopper cars; 900 all-steel, 50-ton box cars; 250 50-ton gondola cars; and 100 all steel, 50-ton automobile cars. Orders for some of this equipment have been announced in recent issues.

New York, New Haven & Hartford.—The New Haven has awarded a contract

(*Continued on second left-hand page*)


GENERAL MOTORS
LOCOMOTIVES
Rio Grande
Rio Grande
5400
2700 Hp. to 5400 Hp. Freight Locomotives
Everywhere West
600 Hp. and 1000 Hp. Switchers
5403
1000 Hp. Road-Switcher
2700 Hp. Transfer Locomotive

amounting to $31,300 to the Foskett & Bishop Company of New Haven, Conn., for the construction of facilities for fueling Diesel-electric locomotives at Dover street, Boston, Mass.

New York, Ontario & Western.—The N. Y. O. & W. has asked the I. C. C. to approve a plan whereby it would issue and sell to the Reconstruction Finance Corporation $162,900 of 2¾ per cent equipment trust certificates, maturing serially at the rate of $8,145 every six months until final payment on November 1, 1951. The proceeds will be used as a part of the purchase price of new equipment costing a total of $181,000 and consisting of five new Diesel-electric, 44-ton switching locomotives, the order for which was announced in the August issue.

Union Pacific.—The U. P. is completing the construction of a 140-ft. turntable at Green River, Wyo., for turning new 4-8-8-4 locomotives, 20 of which are being delivered by Alco.

Supply Trade Notes

HOWARD J. MULLIN, assistant to the sales manager for the Carnegie-Illinois Steel Corporation at Kansas City, Mo., has been appointed assistant to the manager of sales (Pittsburgh, Pa.), with headquarters at Detroit, Mich.

◆

FRANK M. BOSART, former district service representative at Buffalo, N. Y., for the Electro-Motive Corporation, has been transferred to the sales department and will be located at that company's offices at 230 Park Avenue, New York.

◆

GORDON LEFEBVRE, former executive of the American Locomotive Company, has been elected vice-president and general manager of the Cooper-Bessemer Corp.

◆

THE Packless Metal Products Corporation has moved its office and plant to new and larger quarters at 31 Winthrop avenue, New Rochelle, N. Y.

◆

CARNEGIE-ILLINOIS STEEL CORP. — *Paul F. Vander Lippe* has been appointed assistant to the manager of sales in charge of the Kansas City, Kan., office of the Carnegie-Illinois Steel Corporation to succeed *Howard J. Mullin,* who was recently transferred to Detroit, Mich.

◆

B. E. MIDDLETON, formerly Chicago representative for the McKenna Metals Company, has been appointed to represent the McKenna Company in the central New York territory. Mr. Middleton is located at 217 East avenue, Rochester, N. Y.

◆

JAMES A. FARQUHARSON has joined the staff of the O. C. Duryea Corporation as district representative, with headquarters in the Insurance Building, 907 Fifteenth street, N. W., Washington, D. C. Mr. Farquharson was formerly national legislative representative of the Brotherhood of Railroad Trainmen.

◆

COOLIDGE SHERMAN has been appointed Eastern sales manager of the Allegheny Ludlum Steel Corporation. Mr. Sherman has been associated with this company since 1916. From 1922 to 1930, he served as sales manager, Cleveland, Ohio district, for the Ludlum Steel Company, and from 1930 to 1938 as assistant to the president. Immediately previous to his latest appointment he was manager of valve steel sales.

W. T. CAPPS, formerly stoker supervisor of the Baltimore & Ohio, has been appointed sales engineer of The Standard Stoker Company, Inc. Mr. Capps began his business career as a special apprentice with the American Locomotive Company in 1909. In 1912, he was engaged by the Locomotive Stoker Company as draftsman and stoker engineer, which position he held until June, 1917, when he enlisted for service with the 19th Railway Engineers, United States Army. Upon his return from overseas service in July, 1919, he re-entered the employ of the Locomotive Stoker Company as a stoker engineer, in which capacity he remained until February, 1928. Shortly thereafter he was appointed stoker supervisor of the Baltimore & Ohio.

Underwood & Underwood

W. T. Capps

J. A. SAUER, executive vice-president of the Symington-Gould Corporation, has been elected a director of that company to succeed the late C. Loonis Allen.

◆

VAPOR CAR HEATING CO.—*L. A. Richardson,* formerly supervisor of air-conditioning equipment of the Chicago, Rock Island & Pacific, and *Vernon Coon,* formerly of the steam fitting and air-conditioning departments of the Chicago & North Western, have been appointed sales service engineers of the Vapor Car Heating Company, Inc., Chicago, with headquarters at Chicago and New York, respectively.

◆

NATIONAL BEARING METALS CORPORATION. — *William B. Given, Jr.,* has been elected president of the National Bearing Metals Corporation to succeed *J. B. Strauch.* Mr. Strauch was elected chairman of the board, which position was previously held by Mr. Given. Mr. Given is president of the American Brake Shoe & Foundry Co., which company owns a controlling interest in the National Bearing Metals Corporation.

◆

WESTINGHOUSE AIR BRAKE COMPANY.—*D. W. Lloyd* has been appointed Southwestern manager of the Westinghouse Air Brake Company, with headquarters at St. Louis, Mo., to succeed *E. W. Davis,* who retired in August, after 33 years of continuous service with the company. Mr. Lloyd entered the employ of the Westinghouse Air Brake Company in 1911 after graduating from Pennsylvania State College. He held, successively, at Wilmerding, Pa., the positions of special engineer, as-

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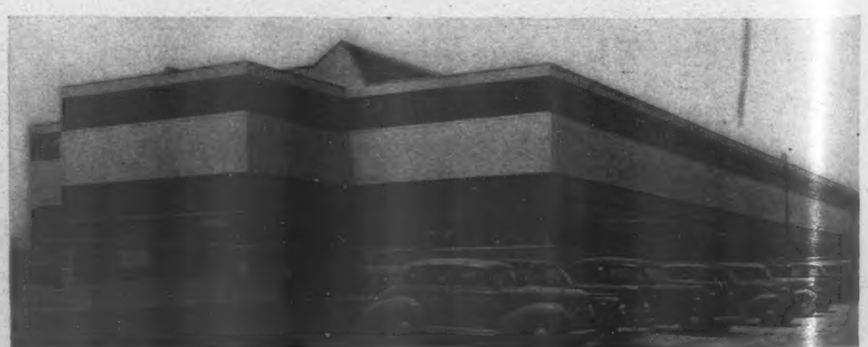


Recently completed machine-tool assembly building of the Bullard Company at Bridgeport, Conn.

The building, one-story in height, is 540 ft. long by 180 ft. wide and is the largest of several additions built during the past year by the Bullard Company to meet expanding defense program demands.

sistant to the chief engineer, assistant engineer of tests, commercial engineer, assistant to the general manager and assistant to the vice-president. In 1928, he was appointed district engineer at St. Louis, Mo., and in 1940 became assistant Southwestern manager, which position he held until his recent appointment. Mr. Davis successively filled the positions of inspector, assistant district engineer, and representative. He was Southwestern manager for 14 years prior to his retirement.

Obituary

JOHN R. SEXTON, eastern sales manager of the Standard Stoker Company, Inc., New York, with headquarters at New York, died on September 22 at St. Luke's hospital, Chicago.

Personal Mention

General

J. J. NAPIER, superintendent of the Canadian National at Dauphin, Man., has retired. Mr. Napier was born in Cannington, Ont., on July 23, 1881, and entered railway service on the Grand Trunk (now part of the Canadian National system) in September, 1900. In 1903 he was appointed a locomotive fireman at Lindsay, Ont., and two years later he was transferred to the Canadian Northern (now part of the Canadian National) as a locomotive engineer on construction work between Sudbury, Ont., and Toronto. He remained on the Central region of the C. N. R. as a fireman, road foreman of engines, and assistant master mechanic until September, 1920, when he was promoted to superintendent, with headquarters at Hornepayne, Ont. Mr. Napier was transferred to Capreol, Ont., in 1926; to Brandon, Man., in 1927; to Melville, Sask., in 1930; to Brandon in 1931; to Winnipeg, Man., in 1933, and to Dauphin in April, 1941.

W. L. HOUGHTON, master mechanic at Chicago, has been appointed assistant superintendent of equipment of the New York Central at Chicago and superintendent of equipment of the Indiana Harbor Belt and the Chicago Junction Railway. Mr. Houghton was born at Toledo, Ohio, on October 28, 1891, and entered railway service on August 1, 1908, as an apprentice at the Beech Grove shops of the Cleveland, Cincinnati, Chicago & St. Louis (Big Four) at Indianapolis, Ind. He was later promoted successively to foreman, piece work inspector and assistant erecting foreman at Bucyrus, Ohio; general foreman at Stanley, Ohio, and assistant general foreman of the Linndale (Ohio) enginehouse. On August 1, 1939, Mr. Houghton became master mechanic at Chicago.

W. L. Houghton

JOHN E. BJORKHOLM, assistant superintendent of motive power on the Chicago, Milwaukee, St. Paul & Pacific, has been appointed superintendent of motive power, with headquarters as before at Milwaukee, Wis. Mr. Bjorkholm was born in Sweden on December 19, 1883, and took a correspondence school course. Before coming to this country he served as a deep sea diver, junior engineer in the submarine service of the Swedish Navy and fireman and junior engineer in the merchant marine. He entered railway service on October 1, 1906, as a fireman on the Milwaukee, later becoming engineer and traveling engineer, with headquarters at Milwaukee. On January 10, 1918, he was promoted to division master mechanic of the Chicago Terminal division, with headquarters at Chicago, and on April 1, 1919, Mr. Bjorkholm became assistant superintendent of motive power.

John E. Bjorkholm

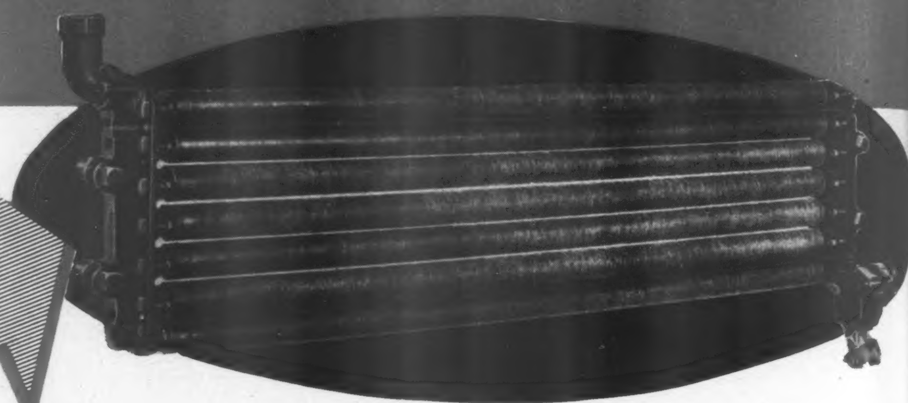
RALPH W. ANDERSON, superintendent of motive power of the Chicago, Milwaukee, St. Paul & Pacific, with headquarters at Milwaukee, Wis., who retired on September 1, was born in Madison county, Iowa, on May 5, 1877, and attended the Capital City Commercial college at Des Moines, Iowa. He entered railway service in 1892, as a machinist apprentice in the shop of the Des Moines Union Railway and in 1897 joined the Chicago, Rock Island & Pacific as a machinist, later serving as assistant enginehouse foreman and enginehouse foreman. In September, 1906, Mr. Anderson became connected with the Milwaukee as a machinist at Mitchell, S. D., and the following year he was promoted to assistant enginehouse foreman. In April, 1908, he was transferred to the Idaho division and two months later was promoted to mechanical foreman of that division. In May, 1909, Mr. Anderson was appointed enginehouse foreman at Avery, Idaho, and in November, 1911, he was transferred to Miles City, Mont. A year later he was promoted to district master mechanic, with the same headquarters, and in June, 1918, he became assistant superintendent of motive power of the Eastern lines, with headquarters at Milwaukee. Two years later Mr. Anderson was promoted to superintendent of motive power of the Eastern lines and in September, 1927, his jurisdiction was extended to cover the entire Milwaukee system.

Ralph W. Anderson

E. M. WILCOX, inventor of the car retarding system, assistant superintendent of equipment of the New York Central, Lines West of Buffalo, and the Michigan Central and superintendent of equipment of the Indiana Harbor Belt and the Chicago River & Indiana, with headquarters at Chicago, retired on September 1. Mr. Wilcox was born at Buffalo, N. Y., on August 13, 1871, and entered railway service in the mechanical department of the Lehigh Valley in 1892. In 1902 he joined the Lake Shore & Michigan Southern (now part of the New York Central) as assistant foreman at Collinwood, Ohio, and was later promoted successively to general foreman at Nottingham, Ohio, traveling foreman at Buffalo, N. Y., division general foreman, general car foreman at Gibson, Ind., and master car builder of the Indiana Harbor Belt and the Chicago Junction at Gibson. In May, 1932, Mr. Wilcox was appointed master car builder for the terminal district of the Michigan Central, and in February, 1933, his jurisdiction was extended to include the Western division of the New York Central, with headquarters at Chicago. In June, 1933, his jurisdiction was extended to include a portion of the Cleveland, Cincinnati, Chicago & St. Louis (Big Four) and in May, 1934, Mr. Wilcox was appointed superintendent of equipment, for the New York Central lines mentioned above, with

(Continued on second left-hand page)

★ WAYS and MEANS to *Maintain the Integrity* of BRAKE PERFORMANCE



★ *Dry* AIR

AFTERCOOLER

The most effective means yet devised for removing moisture from the air supply is our compact radiator type Aftercooler, having automatic drain valve that ejects condensation each time the compressor governor operates. Thus, only dry air can reach the several brake devices, which helps immeasurably in maintaining functional reliability of the whole system.

★ *Clean* AIR

Cartridge Type FILTERS

Remarkably efficient in providing clean air for brake devices, these Filters are used on the compressor inlet, main reservoir pipe, governor connections, and in the brake pipe passage of valves. (Brake cylinders are further protected by a felt seal and breather strainer at the non-pressure end). Particularly noteworthy have been the results with a filter on the compressor — unfailing service continuously between locomotive shoppings.

headquarters at Chicago. On November 1, 1937, the position of superintendent of equipment on the New York Central, Michigan Central and Big Four at Chicago was abolished, and he was appointed assistant superintendent of equipment, with

E. M. Wilcox

the same headquarters. Mr. Wilcox has been active in the Car Department Officers Association for many years, serving as a director from 1937 to 1940. He also served as second vice-president of the Western Railway Club during the year 1936-1937. He is the inventor of the car retarder system, now extensively used on hump yards throughout the country. For his work in this development Mr. Wilcox received the Henderson Gold Medal of the Franklin Institute, Philadelphia, Pa., in 1930.

PAUL MULLEN, master mechanic of the Chicago, Milwaukee, St. Paul & Pacific at Savanna, Ill., has become assistant superintendent of motive power, with headquarters at Milwaukee, Wis.

Master Mechanics and Road Foremen

G. P. ROFFE, general foreman of the enginehouse on the New York Central at Linndale, Ohio, has been appointed master mechanic at Chicago.

ROBERT FLOCKHART has been appointed a road foreman of engines on the Denver & Rio Grande Western with headquarters at Grand Junction, Colo.

H. C. WRIGHT, master mechanic of the Williamsport division of the Pennsylvania, with headquarters at Renovo, Pa., has been transferred to the Middle division.

J. F. KELKER, gang foreman of the Pennsylvania at Conway, Pa., has become assistant enginehouse foreman with the same headquarters.

W. C. FLECK, assistant enginehouse foreman of the New York division of the Pennsylvania, has been appointed enginehouse foreman of the Williamsport, Pa., division.

T. L. PREUN, master mechanic of the Pennsylvania at Buffalo, N. Y., has been transferred to the Williamsport division, with headquarters at Renovo, Pa.

J. F. HUNT, assistant master mechanic of the Pennsylvania, Philadelphia division, has been appointed master mechanic, with headquarters at Buffalo, N. Y.

C. F. MACKALL, assistant road foreman of engines of the Pittsburgh, Pa., division of the Pennsylvania, has been appointed road foreman of engines, Monongahela division.

W. W. HENDERSON has been appointed master mechanic of the Hastings and Dakota division of the Chicago, Milwaukee, St. Paul & Pacific, with headquarters at Aberdeen, S. D.

J. L. BOSSARD, master mechanic of the Hastings and Dakota division of the Chicago, Milwaukee, St. Paul & Pacific at Aberdeen, S. D., has been transferred to Savanna, Ill.

H. D. AHN, assistant engineer motive power in the office of the chief of motive power of the Pennsylvania, has been appointed assistant master mechanic of the Philadelphia division.

EARL FISHER, general foreman on the Denver & Salt Lake at Phippsburg, Colo., has been appointed acting master mechanic, with headquarters at Utah Junction, Colo.

LAUREL BOYNE JOHNSON, general foreman of the locomotive department of the Atchison, Topeka & Santa Fe at Clovis, N. M., who has been appointed master mechanic of the Panhandle & Santa Fe at Slaton, Tex., as announced in the September issue, was born at Whittemore, Iowa, on October 15, 1892. Mr. Johnson entered railway service with the Panhandle & Santa

L. B. Johnson

Fe at Clovis, on May 18, 1910, as an apprentice. He became a machinist on April 10, 1914, and later received a special assignment at the Baldwin Locomotive Works. He became gang foreman at Winslow, Ariz., on September 21, 1914, erecting shop foreman at Clovis on June 22, 1922, and general foreman on May 22, 1941.

E. M. TAPP, assistant master mechanic of the Union Pacific at Salt Lake City, Utah, has been appointed master mechanic of the newly created Utah division, with headquarters at Salt Lake City.

L. E. MCCORKLE, assistant enginehouse foreman on the Norfolk & Western at Bluefield, W. Va., has been appointed assistant master mechanic on the Scioto division with headquarters at Portsmouth, Ohio.

Car Department

FRANK ALT, general car foreman on the Union Pacific at Cheyenne, Wyo., has been promoted to general car inspector, with the same headquarters.

Shop and Enginehouse

G. W. MEREDITH, machinist at the Pulaski, Va., shop of the Norfolk & Western has been appointed night enginehouse foreman with the same headquarters.

HARRY E. TROUP, gang foreman of the Canton, Ohio, enginehouse of the Pennsylvania, has been appointed assistant enginehouse foreman with the same headquarters.

E. E. HINCHMAN, master mechanic on the Southern Pacific at Bakersfield, Calif., has been appointed superintendent of the Los Angeles general shops, with headquarters at Los Angeles, Calif., succeeding G. B. Hart, who has been granted a leave of absence.

Purchasing and Stores

R. I. RENFREW, district storekeeper of the New York Central at Beech Grove, Ind., has been appointed assistant general storekeeper, with headquarters at Beech Grove.

C. L. CLAPP, signal storekeeper of the Leota street shops of the New York Central at Indianapolis, Ind., has been transferred to the position of district storekeeper at Beech Grove, Ind.

W. J. SIDEY, acting general storekeeper of the Lehigh Valley at Sayre, Pa., has been appointed general storekeeper. Mr. Sidey entered railway service immediately after leaving school and served part-time apprenticeships in the car and locomotive shops, drawing room, track section, car service department and accounting department of the Buffalo, Rochester & Pittsburgh (now Baltimore & Ohio) at Du Bois, Pa. He then worked for several wholesale concerns in Rochester, N. Y., in their shipping, billing, and stock departments. He later returned to the Buffalo, Rochester & Pittsburgh in its material supply service. He then worked for six years as storekeeper in charge of material stocks with the General Electric Company in one of its subsidiary plants at Wellsville, N. Y. Mr. Sidey returned to the railroad field in 1922 as division storekeeper of the Lehigh Valley, Jersey City, N. J., serving successively as traveling storekeeper at Wilkes-Barre, Pa.; division storekeeper at Coxton, Pa.; and supervisor of scrap and reclamation at Sayre. He was appointed acting general storekeeper on February 1, 1941, and became general storekeeper in June, 1941. Mr. Sidey has served on committees of the Purchases and Stores division of the Association of American Railroads for the past 12 years, both as a member and as chairman.